february, 1960

nlgi spokesman

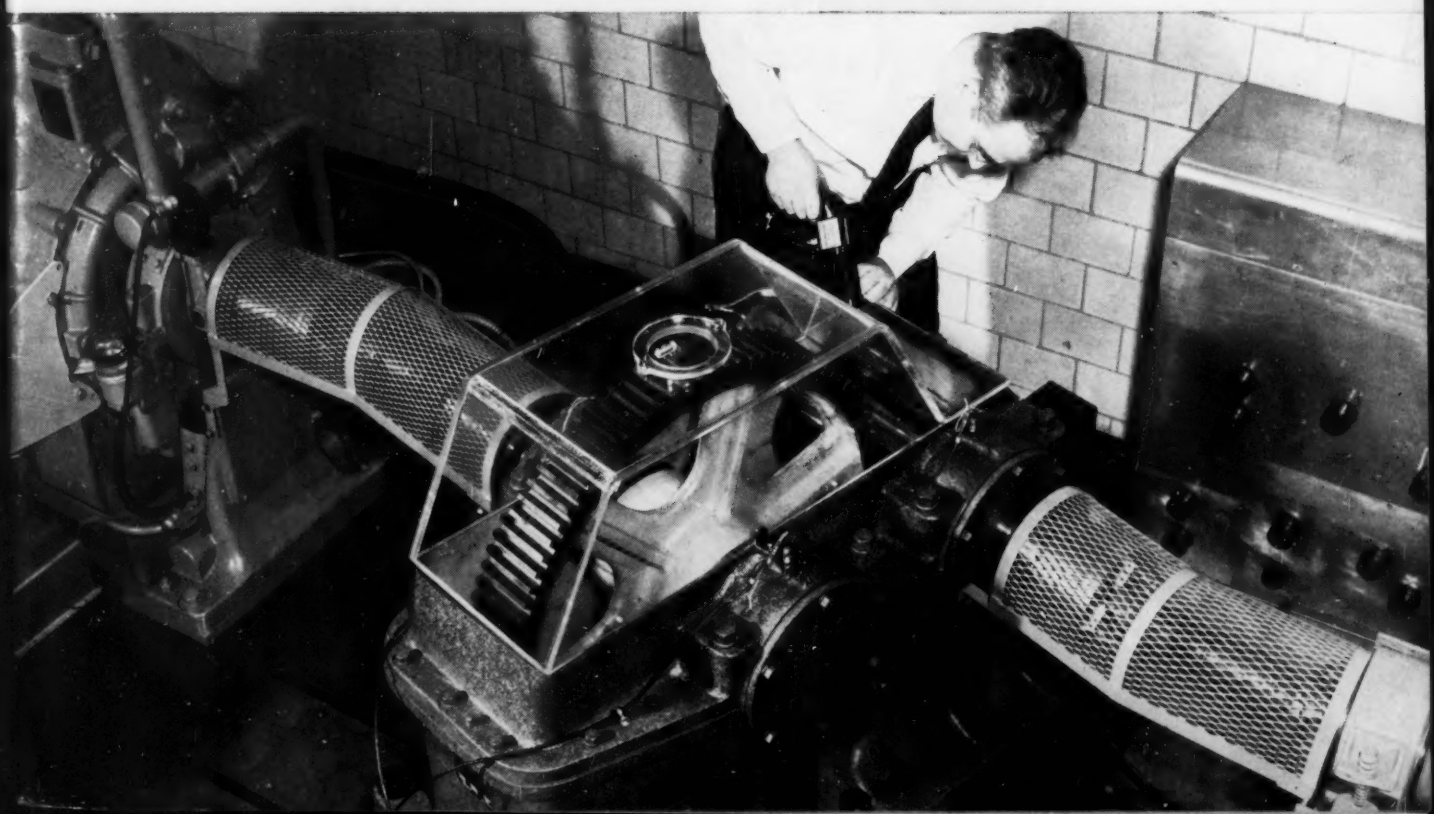
journal of the national lubricating grease institute

Wear Rates in Chassis Lubrication (Bus)
By R. J. KUPPE

A Study of Open Gear Lubrication
By C. R. DANIELS and P. L. MALLOY

A Modified Clay Thickener for Lubricating Fluids
By R. E. FARISS

Review of the Lubricating Grease Industry in Europe and Latin America
By D. C. SANDY



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Oklahoma City, Oklahoma

NLGI PRESIDENT'S PAGE

By H. A. MAYOR, JR., *President*

The Power of Lubrication

Because the hard-hitting information contained in a paper delivered by J. H. Flanagan of the Standard Oil company (Indiana) before the Oil Industry TBA Group, so impressed me, with his permission certain excerpts from the presentation are being brought to your attention. The title of Mr. Flanagan's paper was "The Power of Lubrication."

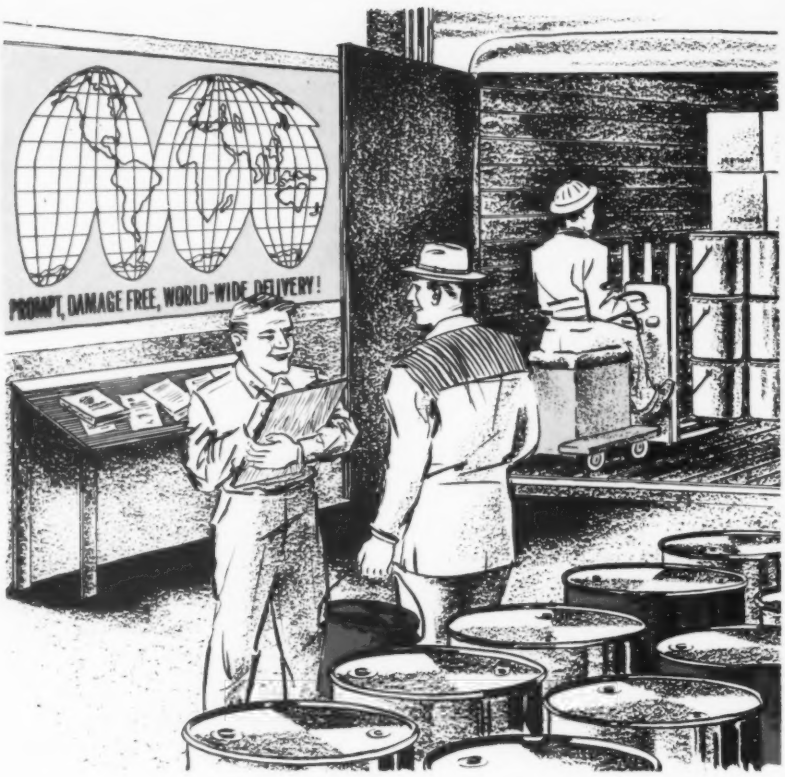
> "Of further comfort to the grease industry is the encouraging results of a service station survey completed by our company which conclusively proved that those stations which had the highest "lube jobs-to-gasoline ratio" also had the highest "motor oil ratio," the highest "tire sales ratio," the highest "battery sales ratio," and the highest "accessory sales ratio." Most importantly, service income per 1,000 gallons of gasoline showed an approximate 70 per cent gain for those high "lube job to gasoline ratio" stations."

Here's a bootstrap which our industry can offer the entire petroleum marketing industry. How better could petroleum industry merchandisers improve service station profit levels? Mr. Flanagan continues:

> Don't underestimate the "Power of Lubrication" in the never ending battle to increase motor oil ratios. Show me the service station dealer who sells eight to ten lubrication jobs or more per 1,000 gallons of gasoline, and I will show you a dealer who seriously doubts the accuracy of the much discussed declining motor oil ratio. As often proclaimed, grease lubrication can truly be the gateway to those all important, but elusive, petroleum marketing profits."

Let's climb aboard this band wagon and spread this impressive gospel. It can't help but greatly assist our industry!

H. A. Mayor, Jr.
President



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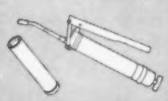
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Volume XXIII February, 1960 Number 11

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THE COVER

AN ultraviolet lamp is used to observe the lubricating life of open gear lubricants in tests conducted by C. R. Daniels and P. L. Malloy, the results of which are contained in their article, "A Study of Open Gear Lubrication," one of the most popular papers presented at the recent annual meeting. The test rig shown enabled the researchers to measure the exposed free metal and draw their conclusions, after a run under certain specifications. The 32-inch cast iron gear was driven by a four-inch pinion gear and connected to a dynamometer for measuring the load. Page 428.

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Future Meetings

FEBRUARY, 1960

25 API Division of Marketing, Lubrication Committee Meeting, Sheraton-Park Plaza Hotel, St. Louis.

24 NLGI Board of Directors Meeting, Park Plaza Hotel, St. Louis.

MARCH, 1960

15-17 SAE National Automotive Meeting, Sheraton-Cadillac Hotel, Detroit.

23-24 Ohio Petroleum Marketers Assn., Annual Convention and Marketing Exposition. Deshler-Hilton Hotel, Columbus, Ohio.

APRIL, 1960

19-20 ASLE, Annual Meeting and Exhibit, Netherland–Hilton Hotel, Cincinnati.

20-22 API Division of Production, Rocky Mountain District Meeting, Gladstone, Henning, & Townsend Hotels, Casper

20-21 National Petroleum Association Spring Meeting, Sheraton Cleveland Hotel, Cleveland, Ohio.

MAY, 1960

16-17 API Division of Marketing, lubrication committee meeting, Bedford Springs Hotel, Bedford Springs, Pa.

18-20 API Division of Marketing Midyear Meeting, Statler-Hilton Hotel, Cleveland

JUNE, 1960

5-10 Society of Automotive Engineers, summer meeting, Edgewater Beach Hotel, Chicago

SEPTEMBER, 1960

14-16 National Petroleum Association Annual Meeting, Hotel Traymore, Atlantic City, New Jersey.

18-21 ASME Petroleum Mechanical Engineering Conference, Jung Hotel, New Orleans.

OCTOBER, 1960

17-19 ASME – ASLE Lubrication Conference, Statler Hilton Hotel, Boston.

30-Nov. 1 NLGI Annual Meeting, Edgewater Beach Hotel, Chicago.

NOVEMBER, 1960

27-Dec. 2 ASME Annual Meeting, Statler Hilton Hotel, New York.

ADVANTAGES
of membership in the
National Lubricating Grease Institute

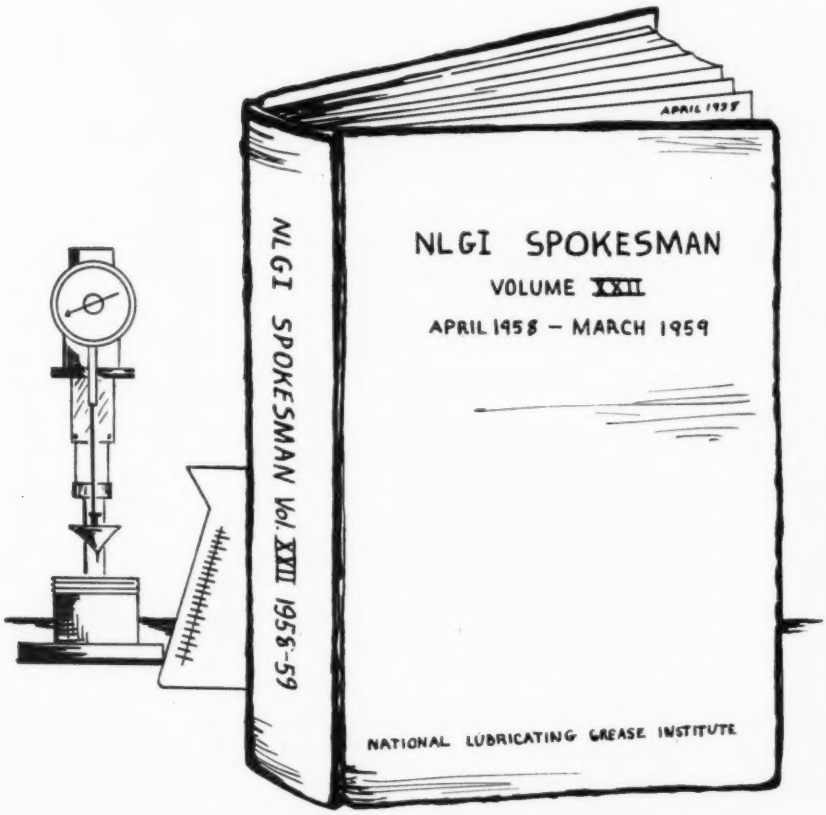
Some of the membership advantages are listed below:

- The NLGI represents over 95 per cent of the lubricating grease industry with members in this country and overseas.
- NLGI has a Technical Committee of 154 members which is divided into nine sub-committees working constantly on industry problems.
- The NLGI SPOKESMAN, a monthly technical journal, is mailed free of charge to key personnel within a member firm. If extra copies of the magazine are needed, they may be purchased at half the regular subscription price.
- The Institute works in close cooperation with affiliated groups including SAE, ASTM, ASA, ASLE, ASME, SAE-Cimtc and IOCA on problems and accomplishments in the lubricating field.
- The main objectives of the National Lubricating Grease Institute are for the development of better lubricating greases for the consumer and better grease lubrication engineering service to industry.

If your firm is interested in becoming affiliated with NLGI, the national office will be happy to furnish further information concerning the organization. Just as 1959 was a banner year for NLGI accomplishments 1960 promises to be even better with more scope and more member advantages.

VOLUME XXII

Now available for your—



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CONTINUING the valuable series of bound volumes of the NLGI SPOKESMAN Volume XXII matches earlier issues with complete coverage of the technical and marketing articles from April, 1958 through March, 1959 . . . twelve issues of the Institute's technical journal, offering some 31 features in all. The green covering with gold lettering matches preceding volumes and the book is a handsome and sturdy reference work for the library or the laboratory. Immediate shipment can be made, upon receipt of order.

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News About NLGI

Survey Questionnaires Are Distributed

All active (manufacturing) member firms in the United States and Canada should have received questionnaires by registered mail, shortly after January 15, 1960, when mailings were made for the third annual production survey.

Mailings were made by Ernst & Ernst, national firm of public accountants handling the survey for the Institute. The questionnaires deal with production during 1959 and are confidential. Any Active member firm not receiving the E&E mailing should advise the NLGI national office, in order that the omission can be rectified.

Assumes Editorial Position

Miss Virginia Allen has joined the NLGI staff, in the position of assistant editor. She replaces Miss Susann Snyder, who recently resigned. Miss Allen is a graduate of the University of Missouri and has had six years of editorial experience in a Kansas City publishing house.

Change in Representatives

Cities Service Oil company has announced that A. G. Griswold is resigning from the NLGI board of directors, because of a change in assignment. P. A. Peterson will assume the position of Company Representative to NLGI for the firm.

Griswold was elected to the board in 1958 and has served on several committees of the Institute. For 1960, he had been chairman of the membership committee and a member of the chassis lubrication and awards committees. He was also NLGI liaison representative to ASA.

Technical Committee Column

CHAIRMAN L. C. BRUNSTRUM

Standard Oil Company (Ind.)

Section Leader in Charge of Research on Greases and Industrial Lubricants

An analysis of membership on the several technical subcommittees revealed the following participation by companies holding active membership in the Institute:

Number of Companies	40+	7	8	9	3	0	2
Number of Committees	0	1	2	3	4	5	6

(Basis 1959 booklet, disbanded Dispensing Panel not included.)

Thus, 24 companies contribute to from one to three committees, a few are on four to six. More than 40 active members do not contribute to the effort of any of the technical subcommittees.

Can it be that even after the Technical Committee reorganization we are still not meeting the needs of over half of the active members? Are over half interested in no technical aspect of the grease industry? Or is it a case of "letting George do it?"

In any case, only the individual members can furnish answers to these questions. Won't you please review your needs and participation and discuss the matter with the chairman or vice-chairman, M. J. Pohorilla or M. L. Carter? Participation is open to all, but unless we resort to a draft system, it must be on the individual's own initiative. Although this survey was based on active membership, participation is open to *all* classes of membership.

At present the technical subcommittees (using an abbreviated name) are as follows:

Front End Lubrication
Definitions of Terms
Gear Lubrication
Dispensing
Research
Consistency
Editorial
Manufacturing
SPOKESMAN Procurement

Let us know if you will work on one of these or if you have a problem not covered by this list.

1960 Report— How Baragel* and Baragel* 24 improve grease efficiency

BARAGEL extends versatility as a non-soap gelling agent

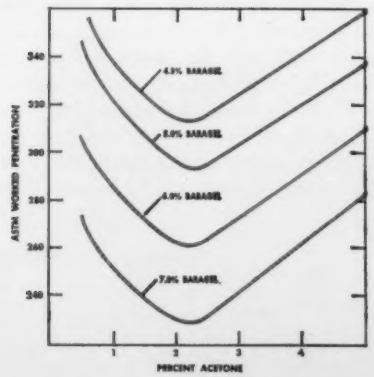
Among the non-soap gelling agents used by grease compounders, BARAGEL has been coming to the fore as a versatile gelling material. Lubricating greases made with this product of Baroid Chemicals, Inc., show practically no change under extremes of heat, cold or moisture.

Technically, BARAGEL is a reaction product of mixed organic ammonium halides and refined sodium montmorillonite. A common organic antioxidant is included in the reaction mixture to provide built-in oxidation inhibiting properties.

As its chemical nature indicates, BARAGEL is a member of the BENTONE* family of products. BENTONE 34 has been outstandingly successful in lubricating greases, paint, plastics, inks and other fields. Experience indicated that even further efficiency could be achieved by tailoring the product to suit a specific application. BARAGEL is the result of research directed to make the product meet the needs of the lubricating grease industry.

BARAGEL efficient in greases made with high VI oils

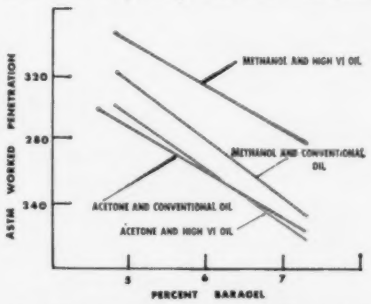
BARAGEL has proved to be efficient in greases compounded with all types of petroleum oils, including solvent refined, high VI oils. Tests were made with a base oil of 30.4° API gravity at 60° F and a viscosity of 356 SUS at 100° F.



BARAGEL was stirred into the oil, acetone added and stirred, and the mixture was milled. Greases having an ASTM worked penetration in the 315 range required about 4.5% BARAGEL, while greases in the 280 range required about 5.5% BARAGEL. Data Sheet A-1, available on request, gives full details of this test.

BARAGEL works efficiently with wide range of dispersing aids

As a grease gelling agent, BARAGEL works well in oils of low, medium or high viscosity, where the dispersion aid is either acteone or methanol. The influence of the dispersion aid may vary between different



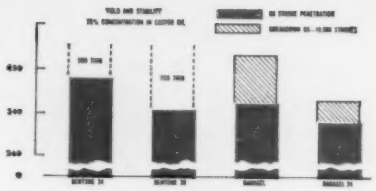
oils. The chart shown here illustrates the changes resulting from use of oils of varying viscosity.

It will be noted that the influence of acetone on yield at optimum concentration is essentially the same for both a conventionally refined oil and a highly refined, high VI oil. There is, however, a marked difference in the influence of methanol on yield at optimum concentration in the same two oils.

Complete details of a series of conclusions drawn from tests are available on BARAGEL Data Sheet A-8.

Greases made with castor oil

BARAGEL 24 has been proved by tests to be exceptionally efficient in thickening castor oil. Greases prepared with BARAGEL 24 are also much more stable to working in the ASTM grease worker.



Tests were made to compare results when thickening greases with BENTONE 34, BENTONE 38, BARAGEL and BARAGEL 24. The results are shown in the accompanying chart and details are available in Data Sheet A-5.

Worked penetrations of greases made with castor oil and 10% BARAGEL 24 were 325, with a penetration of 365 after working 10,000 strokes.

BARAGEL 24 improves efficiency in non-petroleum oils

Just as BARAGEL was the result of specialized research to make BENTONE 34 even more effective as a grease gelling agent, in the same manner BARAGEL 24 has been developed as an improvement over BARAGEL in thickening greases made with non-petroleum oils.

BARAGEL 24 works unusually well in compounding greases made from such non-petroleum oils as polyalkylene glycols, di-2-ethylhexyl sebacate, di-2-ethylhexyl adipate and castor oil. While BARAGEL 24 may not find widespread use in thickening most petroleum oils, it is possible that BARAGEL 24 may prove to be best for certain specific petroleum oils.

The improved efficiency of BARAGEL 24 in non-petroleum oils has been achieved primarily through the nature of the organic ammonium halide used. The inorganic portion of the product is refined sodium montmorillonite.

BAROID

BAROID CHEMICALS, INC.

A SUBSIDIARY OF NATIONAL LEAD COMPANY

1809 SOUTH COAST LIFE BLDG.

HOUSTON 2, TEXAS

* Trademark of National Lead Company for its organic ammonium montmorillonite.

Presented at the NLGI 27th annual meeting in New Orleans, October, 1959

Wear Rates in Chassis Lubrication (Bus)

By:
R. J. Ruppe
Chicago Transit Authority

Invitation to Authors

C. J. Boner, chairman of the committee for procurement of technical papers for the NLGI SPOKESMAN, *invites all readers to consider submitting original work for publication in the journal. Any aspect of lubricating greases or fluid gear lubricants is acceptable and the author(s) have complete freedom to such phases that they might wish to write about. The traditional restraint concerning commercial references would be maintained, and all papers would be considered by the subcommittee on editorial review.*

E. W. Campbell, chairman of the NLGI SPOKESMAN *advisory committee, has issued a similar invitation concerning marketing articles, which might cover sales, sales promotion, advertising or distribution. All material should be sent to the national office.*

Digest

The maintenance of over 3,000 city busses which operate in all types of weather poses many problems. Wear and corrosion of the chassis must be kept to a minimum to provide good performance and prevent equipment failures. A one year test program was set up to measure wear by micrometer measurement of the spring suspensions of eight busses in regular service in Chicago. This program was also arranged to provide information for possible improvement in lubrication practice. Two thickener types, lithium and inorganic, and an E.P. gear oil were used, and two busses were equipped with two types of centralized lubrication systems. The effect of varying the lubrication interval was also investigated. Shackle wear rates and failures were at a minimum for lubrication intervals up to 2,000 miles for the lithium greases; beyond this the wear and failure rates increased. Higher wear rates and more failures occurred with inorganic grease at 2,500 and 3,000 miles. Oil was the poorest lubricant probably because it failed to stay in the shackles. Most of the wear occurred in the bottom shackles and most of the failures took place in the center shackles of the rear axle. A substantially better grease is required before the lubrication interval can safely be extended beyond 2,000 miles.

Introduction

The maintenance of over 3,000 city busses which operate in all types of weather poses many problems. Among the problems which represent a substantial proportion of the man-hour budget are those concerned with lubrication of the chassis. Assurance of satisfactory service requires a frequent lubrication schedule of the chassis system in order to reduce wear and corrosion which, to a large degree, are responsible for driver complaints and equipment failure.

The reduction of wear and corrosion is the primary purpose of a good chassis lubricant. Wear of course occurs in any bearing, but it is minimized by proper lubrication. Wear is generally recognized by an increase in steering effort, a rougher ride, and more noise. Bearing corrosion is also a factor to be considered since it will ultimately tend to increase friction and wear. In extreme cases of poor lubrication or excessive corrosion the bearing surfaces become welded or frozen and fail to function.

Several features are desirable in the lubricant if it is to reduce wear satisfactorily. First, the lubricant should obviously be formulated of quality materials, should itself be completely free of contamination, and should reduce friction to a minimum. In order to provide good lubrication for a reasonable period, a lubricating grease rather than an oil is generally recommended because it remains in place. In order to stay put for extended periods, a suitable grease should have both good metal adhesion and good mechanical stability. An additional factor influencing the retention of the grease is its ability to resist water washing. If the grease resists this action well, it will be able to maintain a protective collar around and a good film on the lubricated part; conversely, if easily washed out, the bearing will be forced to operate without an adequate lubricant film, and in addition it will be vulnerable to the entrance of dirt and foreign matter which will accelerate the wear.

Water also enters the picture in a second manner, as the lubricant should resist the corrosion and the resulting increase in wear which the water will promote. The operation of this particular fleet in relation to corrosive wear is further complicated because thousands of tons of salt are deposited on the city streets in winter thereby further accelerating corrosion.

It is time-consuming, expensive, and difficult to determine wear quantitatively on commercial equipment, particularly in a bus fleet where down-time must be kept to a minimum. Probably for these reasons no precise information relating to the wear under actual service conditions has been available. Because of our interest in reducing the frequency of lubrication and improving equipment life, a program was initiated by our Technical Services Division to measure wear in busses in regular service.

Experimental

A test program was set up in April of 1953 to measure wear by micrometer measurements on eight busses in regular passenger service in Chicago. Certain variations were incorporated in this test so that an improved lubrication practice, as well as the wear measurements, might evolve from this work. The variations included different: (1) lubrication schedules, (2) lubricants, and (3) modes of applying lubricant.

The busses used were the type which gave the most difficulty in service. Both shop and field complaints relative to lubrication frequency and technique were common. The shackle design of the suspension made it difficult to provide and maintain a proper lubricant film on the pins. Each bus had a total of twenty eight pins and bushings which were suitable for wear measurements by micrometer.

TABLE I

Lubricants and Distribution for Busses

Lubricant	*Application*	*Lubrication Interval Miles*
Lithium Grease A	Manual	1,000
Lithium Grease A	Manual	1,500
Lithium Grease A	Manual	2,000
Lithium Grease A	Manual	2,500
Inorganic	Manual	2,500
Inorganic	Manual	3,000
Lithium Grease B	Centralized—One Point	100 (daily)
E.P. Gear Oil	Centralized—Automatic	4 (25 times daily)

Six of the busses were equipped for conventional grease lubrication, and two were provided with centralized lubricating systems. One system permitted grease lubrication of all suspension parts from one point; the other provided completely automatic lubrication with oil.

Three greases and an E.P. gear oil were used. Two of the greases were thickened with lithium soap, the third had an inorganic thickener, and all had similar oil viscosities. The E. P. gear oil was of SAE 140 classification.

The spring suspensions of all eight busses were completely overhauled with new pins and bushings installed. Dial indicator readings to one thousandth of an inch were taken of pin play in the bushings at the beginning and at the end of the test. The difference between these measurements was wear. The six busses which were grease lubricated in the conventional manner were equipped with special grease fittings to prevent mistakes during the program.

The lubricant type, method of application, and lubrication period are presented in Table I. As shown,

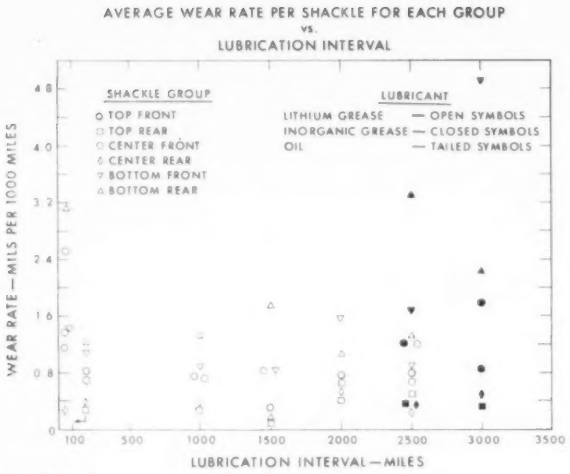


FIGURE 1.

the lubrication interval for the six conventionally lubricated busses varied from 1,000 to 3,000 miles by 500 mile differences. One lithium grease and the inorganic grease were used in these busses. The other lithium grease was applied daily to the bus equipped with the centralized grease system. The automatic system forced oil to all suspension points at every sixty brake applications, or the equivalent of approximately 25 times daily.

Discussion of Results

The test was completed after one year as planned, and several interesting features were determined upon analysis of the results. The wear pattern was determined for the individual busses, the various lubrication intervals, and the different lubricants. As may be expected in any extended field tests, final measurements of some parts could not be made. This occurred in 37 instances out of a possible 448. Examination of these failed shackles contributed to the conclusions.

For the purpose of determining the wear rate in the different locations on a bus, the suspension pins and bushings were grouped as top, center, and bottom, and further classified as front axle or rear axle for each of the three groups. A plot of the average wear rate for each of these six shackle positions for each bus is shown in Figure 1. This Figure illustrates wear was greatest in all the bottom shackles in every instance for the seven grease-lubricated busses. Furthermore, the bottom rear bearing position appears to present the most severe wear although the highest wear rate, 4.92 mils per 1,000 miles, occurred in a bottom front location. In the oil lubricated bus, wear was likewise greatest on the bottom rear axle pins and bushings, although the bottom front location did not show quite as much wear as the top rear location.

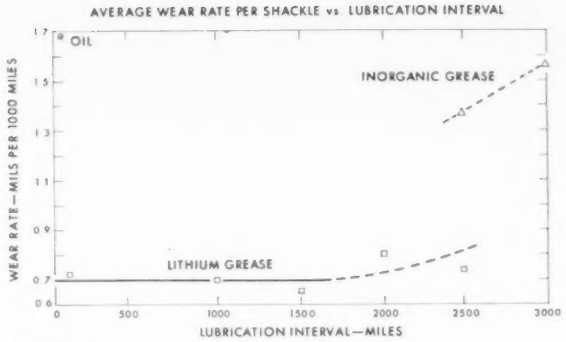


FIGURE 2.

The shackle positions showing the smallest wear rates are equally well defined by Figure 1. Without exception on the grease lubricated busses, the top and center shackles of the rear axle showed the least wear with an average of 0.33 and 0.37 mils per thousand miles respectively. On the oil lubricated bus the center rear and top front shackles showed the lowest wear rates, 0.28 and 1.2 mils per 1,000 miles. The average wear for each shackle group for the grease lubricated busses and the oil lubricated bus is summarized together with the number of shackle failures in Table II.

Figure 2 shows a plot of the average wear rate per shackle for each bus by lubrication interval. No difference is apparent here for the lithium greases for lubrication intervals extending from 100 miles to 2,500 miles. However, reference to Table III, which summarizes the total mileages, wear rates, and type of shackle failure for each bus, shows two shackles were too badly corroded to permit readings at the latter interval. A higher wear rate at this interval would otherwise have been obtained, and a trend towards higher wear with less frequent lubrication would result as indicated by the broken line in the Figure.

TABLE II

Average Wear Rate Per Shackle and Shackle Failures by Group

		Grease Lubricated Busses		*Oil Lubricated Bus*	
Shackle Group	*Shackles per Bus*	*Wear**	*Failures***	*Wear**	*Failures***
Bottom Rear	4	1.76	1	3.14	—
Bottom Front	4	1.70	2	1.4	—
Top Front	4	0.92	1	1.15	—
Center Front	6	0.82	3	1.37	—
Center Rear	6	0.37	7	0.28	4
Top Rear	4	0.33	0	2.5	1

* Average wear in mils per 1,000 miles
** Mainly frozen pins and excessive corrosion

TABLE III

Wear Rates and Shackle Failures by Bus

Lubricant	Lub'tn. Interval Miles	Total Miles	Average Wear Rate per Shackle (mils/1000 miles)	Frozen Pins	Corrosion Failures	Loose Bushings	Misc.
Li B	100	41,354	0.72	—	—	—	—
Li A	1,000	36,962	0.70	—	—	1	—
Li A	1,500	41,709	0.66	—	—	—	—
Li A	2,000	42,060	0.80	—	—	—	—
Li A	2,500	42,186	0.74	—	2	—	—
Clay	2,500	32,679	1.36	2	—	—	—
Clay	3,000	32,346	1.57	6	—	2	1
E.P. Gear Oil	4	37,967	1.68	4	—	—	1

The two busses lubricated with the inorganic grease at the longest lubrication intervals had wear rates considerably higher than those lubricated with the lithium greases. The large difference is mainly due to the very high wear rates which occurred in the bottom bearings. In addition, more unmeasurable parts occurred in these two busses as shown in Table III. On the 2,500 mile schedule two frozen pins occurred, and on the 3,000 mile schedule six pins, or slightly more than 20 per cent of the shackles, had seized at the end of the test. Considering that these busses traveled roughly 20 per cent fewer total miles than the others, the wear rate and failure rate are even more significant.

Two main features seem apparent. First, the wear rate and failure rate both tend to increase rapidly as the lubrication interval is extended beyond the 2,000 mile period. Second, a difference between the wear inhibiting ability appears to exist between the two grease types, a wear-rate factor of nearly 2 to 1 being present in the two 2,500-mile schedule busses lubricated with the inorganic and lithium thickened greases respectively.

The oil-lubricated bus shows the highest wear rate despite its very frequent lubrication. The incidence of frozen pins is also relatively high, about 15 per cent. This poor showing is probably related to the failure of the oil to stay in the bearings.

Conclusion

A difference exists in the wear rates of the various parts of busses. The bottom shackles wear at a much greater rate, and this difference could be due in part to design and loading considerations. It probably is also related to the greater possibility of contamination of these shackles by foreign material and water washing combined with corrosion.

No marked difference was found in wear rates as determined by varying the lubrication interval up to 2,000 miles for lithium grease. The failure of two shackles on the bus lubricated at 2,500 miles probably indicates an increase in wear rates and shackle failures would have been experienced if the interval had been extended much farther.

The inorganic-based grease seems to produce a higher wear rate than the lithium-based greases, particularly in the more severe bottom location. For the comparable busses on the 2,500 mile lubrication schedule the wear rate was nearly twice as great with the inorganic grease. This grease also showed a marked rise in wear rate and part failures when the lubrication interval was extended to 3,000 miles.

Lubricating with oil rather than grease gave poorer results, even though the lubrication interval was 25 times daily. Failure to remain in the shackles is the most plausible explanation.

A better grease is required if the average wear rate is to be reduced and an extension of the lubrication interval is to be realized. This grease must have the ability to stay put and to reduce the wear rate by a very substantial amount in those parts which wear most rapidly. Until such a grease is available, lubrication every 2,000 miles is required to give assurance of low wear and a minimum number of part failures. ■

About the Author

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A Study of Open Gear Lubrication

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Presented at the NLGI 27th annual meeting in New Orleans, October, 1959

"Open gears," for the purposes of this discussion, include such devices as rotary kiln gears, crane and shovel gears, draglines, chain and sprocket drives and so forth. From a lubrication point of view, open gears present a dual problem in that the lack of housing makes relubrication clumsy, while exposure of the gears to contamination and the elements makes frequent relubrication necessary.

This discussion of open gear lubricants covers:

1. The relationship between composition and performance of gear lubricants.
2. The development of laboratory methods to evaluate improved lubricants.
3. Comments on field performance of these lubricants.

Formulation of Improved Open Gear Lubricants

Open gear lubricants have usually been composed of blends of asphaltic materials and lubricating oils. It has been known that the lubricant life span was increased by increasing the viscosity of the blends but very high viscosity has serious disadvantages. Semi-solids, such as ordinary soap-thickened greases, are poor lubricants for open gear teeth.

Analysis of the problem showed, in simple terms, that improved lubrication of open gears required:

1. Viscosity such that application of the lubricant would be facilitated.
2. Adhesiveness of the lubricant to the metal surface.
3. Rheological properties such that the lubricant would be retained and/or replenished on the gears after the wiping action of the meshing teeth.

Little attention has been paid previously to the nature of the diluent oils used in oil-asphalt blends for

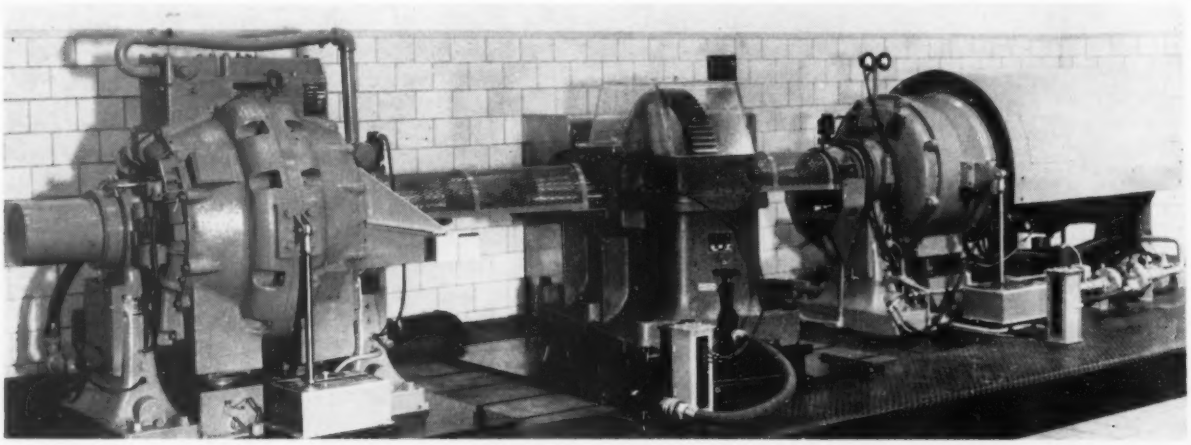

FIGURE 1—Enclosed open gear rig (center) designed to test open gear lubricants, as described above.

FIGURE 2—Ultraviolet lamp measures the lubricant life during the tests, showing exposure of free metal.

lubricating open gears. More attention has been paid to the asphaltic components. The mineral oil components have usually been of the mixed base or naphthenic type. The viscosity of the diluent oils has ranged from about 60-300 SUS/210°F.

We set out to investigate the influence of the type of base oil used in open gear lubricants. Our study showed that superior lubricants are obtained with diluent oils having high aromatic content, with aniline points from about 80-120°F. and viscosity indexes below 0. These aromatic oils are, for example, phenol extracts from lubricating oils. They have excellent solvent properties for asphalts. Conversely, upon blending asphaltic materials with relatively high viscosity index oils, gels or semi-gels are obtained.

TABLE I
Diluent Oil Inspections

Designation	*Viscosity Sus/210°F.*	*V. I.*	*Aniline Point, °F.*
1	73	17	218
2	73	49	190
3	73	− 48	97
4	59	−115	88
5	143	−235	111
6	358	−330	118

Table I shows inspections on 6 diluent oils in order of decreasing viscosity index. Oils 1 and 2 are typical of the naphthenic oils commonly used in open gear lubricants. The aniline points 218 and 190 indicate relatively low aromatic content. Oils 3 to 6 have lower viscosity indexes and lower aniline points indicative of relatively high aromatic content. In the following tables these oils will be referred to by these numbers and numbers 1 and 2 will refer to oils with VI's above 0 and with high aniline points, oils 3 to 6 will refer to the oils with VI's below 0 and with relatively low aniline points.

In formulations containing these highly aromatic oils both reduced asphalts and "reduced and oxidized" asphalts were used. The type of asphalt was found to be a less important variable than the type of diluent oil used.

Another factor controlled by composition is the

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fiber structure of the lubricant. In tests on a laboratory test rig (described below) there appeared to be a definite correlation between lubricant life and degree of fiber structure. Lubricants possessing a long fibered structure gave longer lives on the gear rig tester than materials of short fiber or more waxy structure. Formulations were developed with increased fiber structure by incorporating linear coiled polymers which enhance the natural stringiness of the aromatic oil-asphalt blends. The most effective agents found were polymers of isobutylene or copolymers of isobutylene and styrene.

Laboratory Evaluation of Open Gear Lubricants

These open gear lubricants were evaluated on a gear rig designed to test the life of an open gear lubricant. The test rig is shown in Figure 1.

In the test rig a 32-inch pitch diameter cast iron gear is driven by means of a 4-inch pinion gear which is connected to a dynamometer for measuring the gear load. The gears are lubricated with the test lubricant and run at a temperature of 80 to 90°F. at uniform pinion gear speed of 400 RPM and a load of 750 lbs. per tooth until the lubricant wears off the gear teeth and exposes free metallic surfaces. The hours to exposure of free metal is reported as the lubricating life of the lubricant. The exposure of free metal was observed by the use of ultraviolet light and taken to be the point at which the normal fluorescence of the lubricant was no longer observed on an area about a half inch long.

Figure 2 shows how the lubricant life was measured by the use of an ultraviolet lamp. The lubricant life, as previously mentioned, was taken as the time interval before bare spots appeared on the gear teeth. The bare spots were detected as an absence of fluorescence on an area about ½ inch long.

Some of the results obtained by this means are shown in Table II. The table shows the composition of the asphalt-oil blends in the range of about 1,450 Saybolt seconds at 210°F. Two kinds of asphalt are used; A refers to a reduced asphalt from Talco crude and B refers to a reduced and oxidized Venezuelan asphalt.

It can be seen under the gear rig life that the naphthenic type oils give lower gear rig lives than the aromatic oil blends of approximately the same viscosity.

The next table, Table III, shows the same trend at a somewhat higher viscosity level. Naphthenic oils give gear rig lives of 6 hours and 2 hours, and the aromatic oil of approximately the same viscosity gives a gear rig life of some 21 hours.

Table IV shows the same sort of results obtained at a viscosity level of about 5,000 Saybolt seconds at 210°F. The naphthenic oil gives a gear rig life of about 5 hours. The aromatic oils, of approximately the same viscosity, give gear rig lives of up to 24 hours.

It was noted in the gear rig tests that the gear lubricant life seemed to correlate with the fiber structure

TABLE II
Gear Rig Test Results

Asphalt[1] *Wt. %*	*Oil*[2] *Wt. %*	*Blend Vis. Sus/210°F.*	*Gear Rig Life, Hrs.*
63-A	37-(1)	1450	8
58-B	42-(2)	1400	3
55-A	45-(3)	1470	16
40-B	60-(6)	1470	13
52-B	48-(5)	1460	20

1. A—reduced asphalt, Talco crude
   B—reduced and oxidized Venezuelan asphalt
2. Numbers 1-6 refer to Table I

TABLE III
Gear Rig Test Results (Cont.)

Asphalt[1] *Wt. %*	*Oil*[2] *Wt. %*	*Blend Vis. Sus/210°F.*	*Gear Rig Life, Hrs.*
58-A	42-(2)	1840	6
58-B	42-(2)	2120	2
60-A	40-(3)	1940	21

1. A—reduced asphalt, Talco crude
   B—reduced and oxidized Venezuelan asphalt
2. Numbers 2 & 3 refer to Table I

TABLE IV
Gear Rig Test Results (Cont.)

Asphalt[1] *Wt. %*	*Oil*[2] *Wt. %*	*Blend Vis. Sus/210°F.*	*Gear Rig Life, Hrs.*
71	29-(2)	5040	5
58	42-(6)	4200	11
72	28-(4)	4630	18
68	32-(5)	5510	24

1. Reduced and oxidized Venezuelan asphalt.
2. Numbers 2-6 refer to Table I.

TABLE V
Gear Rig Test Results (Cont.)
Effect of Isobutylene Polymers & Copolymers

Asphalt Wt. %	*Oil Wt. %*	*Polymer Wt. %*	*Gear Rig Life, Hrs.*
44	55	—	15
44	54	2[1]	17.5
46	54	—	26
46	53.5	0.5[2]	36

1. Polyisobutylene.
2. 50-50 Styrene-polyisobutylene.

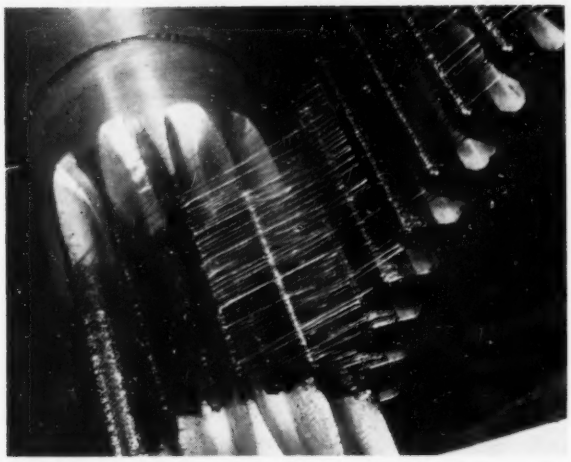

FIGURE 3—Behavior of lubricant on running gear teeth.

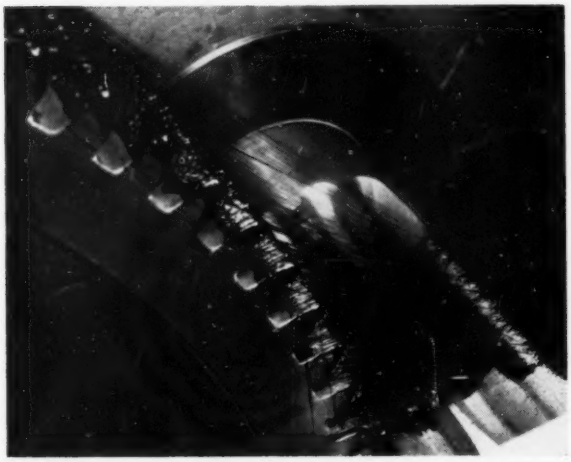

FIGURE 4—Fibrous structure of the lubricants (side).

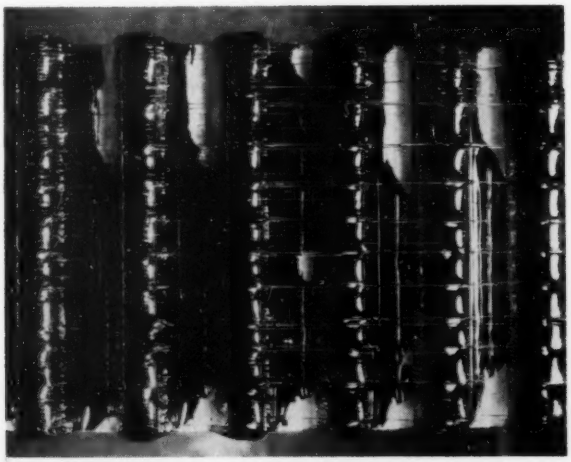

FIGURE 5—Fibrous structure (looking down) on gear.

of the lubricant. For this reason tackiness agents were added to the lubricants to increase the fiber length. These tackiness agents were, for example, polymers of isobutylene or copolymers of isobutylene and styrene. Table V shows some results of gear rig tests on formulations with and without added tackiness agents. It can be seen that the addition of about 2 per cent of polyisobutylene increased the gear rig life by 2½ hours in one typical case while the addition of ½ per cent of a 50-50 copolymer of styrene and isobutylene increased the gear life by 10 hours in another typical case.

Figure 3 shows the behavior of the lubricant on the running gear teeth. Figures 4 and 5 show the fibrous structure of the lubricants on the gear teeth from different angles. It will be seen that the stringiness of the lubricant is such that the supply of lubricant is replenished on the gear teeth as they emerge from contact. It is this stringiness and the consequent redistribution of the lubricant on the gear teeth which accounts for the increased lubricant life of these formulations. For optimum results, the blends must have a balance of adhesion of the asphaltic blend to the metallic surfaces and cohesion of the lubricant such that the strands of lubricant continually replenish as the lubricant is wiped off the meshing teeth.

The improvement in open gear lubrication which is indicated by the laboratory rig tests, and which can be readily appreciated from the appearance of the lubricant on the gear teeth as shown on the photograph, has been confirmed in field applications. For example, (1) a rock conveyor belt gear drive, working under alternately wet and dusty conditions, previously required lubrication every two hours. Now with the improved products the lubrication interval is once a day. (2) Open gears on a power shovel and crane working in dirty and wet conditions demonstrated the superiority of these improved products by changing from a lubrication schedule of four times per shift, using conventional gear lubricants, to once per shift using these new improved products, (3) a rotary kiln gear drive operating at 110 to 120°F. with moderate dust was being lubricated once every day with a conventional gear lubricant.

With the new improved products, the relubrication period was increased to once every 3 days.

From the point of view of lubrication technology, the main interest in these new products is the adaptation of unique rheological properties to the solution of this particular lubrication problem. Formulation of products to optimize the adhesion to metal surfaces and cohesion of the lubricant successfully provided improved lubrication performance on open gears. Previous studies on the use of EP additives, high viscosity oils or ordinary soap-thickened greases had failed to provide satisfactory results. ■

A Modified Clay Thickener For Lubricating Fluids

By: R. E. Fariss
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Abstract

A new gelling agent for the preparation of lubricating greases is described. Based upon a specially processed clay and dimethyl alkyl benzyl ammonium chloride, the product is known commercially as Baragel 24. Laboratory data are given on a number of the important variables encountered in grease manufacture. The preferred mineral oil for use with this gelling agent is described. Correlation is made between grease performance and the physical properties of the oil. The effect of dispersants and their concentration on the yield and mechanical stability of the resultant greases is discussed. Correlation is also shown between the nature of the oil and the amount of dispersant required. Procedures for preparing the greases are discussed and the relationship between process, oil and dispersant with regard to yield and mechanical stability is discussed. The effect of antioxidants, corrosion inhibitors and extreme pressure additives on the yield, mechanical stability and behavior of the greases is described. A method is given for the preparation of greases with synthetic and vegetable oils. The physical properties of these greases are given and a dispersant suggested for each system.

Introduction

The Bentone* gelling agents were introduced commercially to the lubricating grease industry in 1949. Consisting of a clay base and an organic cation, these gelling agents found application throughout the industry[1-5]. Bentone 34 and Bentone 18, based on Wyoming bentonite, were the pathfinders of this unique class of non-soap gelling agents followed by Bentone 38, based on hectorite. These gelling agents were found to be suitable for preparing premium greases in lubricating oils provided the oil had certain properties. Principally, a highly refined base oil was required. With the move to both higher and lower temperature applications[6], emphasis was placed on developing lubricating greases to meet these demands. This required using synthetic fluids for a number of these applications and the thickeners available met with only moderate success. In an effort to provide a product suitable for use in synthetic fluids, an evaluation

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was made of the effect of the nature of the cationic group on the behavior of the Bentone gelling agent. As a result of this study, a product of a specially processed Wyoming bentonite and a dimethyl alkyl benzyl ammonium chloride was developed. Tailored for the lubricating grease industry, this product has been designated Baragel* 24.

Behavior in Mineral Oils

Customarily, any modified clay product developed for use in the lubricating grease industry is evaluated in a number of mineral oils. Although Baragel* 24 was developed primarily for use in the synthetic and non-mineral oils, it was found to have desirable properties in certain of the fluids not suitable for the Bentone gelling agents previously described. In order to correlate this performance with the nature of the oil, the following physical properties of the oil were measured:

Gravity, °API @ 60°F:
Viscosity, SUS @ 100°F:
Viscosity, SUS @ 210°F:
Viscosity Index:
Index of Refraction:

The specific gravity was determined by means of a Christian Becker Westphal balance. Kinematic viscosities were obtained using the modified Ostwald-Cannon-Fenske pipet. An American Optical Abbe' refractometer was used to determine refractive index. The use of the index of refraction-gravity constant method to determine the constitution of a mineral oil is described in a paper by Kurtz[7]. By this means, the oils were classified as to aromatic, paraffinic and naphthenic content. These data are given in Table 1.

TABLE 1

Physical Properties of Test Oils

	A	B	C	D	E
Gravity, ° API @ 60°F:	30.4	21.3	16.9	28.4	20.1
Viscosity, SUS @ 100°F:	356	517	309	346	1534
Viscosity, SUS @ 210°F:	55.5	55.1	48	52.9	92
Viscosity Index:	93	33	26	80	56
Index of Refraction:	1.4801	1.5069	1.530	1.4829	1.5218
$\%C_A$	7	16.5	28	0	25
$\%C_N$	23	32	37	40	20
$\%C_P$	70	51.5	35	60	55

Greases were prepared using each of the above oils with Baragel 24 and Bentone 34. Using the Armstrong[8] type kettle, greases were made by adding the thickener to the oil, stirring, adding 3 per cent acetone and then heating to 300°F while continuing to stir. When the mix had cooled below 200°F, 0.1 per cent water was added. The greases were allowed to cool to approximately 150°F, milled at a rate of 0.4 lb per min through a No. 2 laboratory model Tri Homo disperser set at 0.001 inch rotor-to-stator clearance. After remaining at least 24 hours in a room maintained at 75°F ambient temperature, the penetrations of the greases were measured. These data are given in Table 2.

TABLE 2

Comparison of Baragel 24 with Bentone 34 in Various Mineral Oils

Oil	*ASTM Unworked Penetration, mm x 10*		*Percent Thickener*
	Baragel 24	*Bentone* 34	
A	310	259	7
B	259	280	6
C	265	306	5.5
D	286	252	7
E	237	287	6

An alternative procedure used a drill press equipped with pitched sweep blades for the stirring. A concentrate utilizing the gelling agent, the dispersant and one-third of the oil is normally prepared in the "drill press or batch process". The remainder of the oil is then added and the material processed as described above. The "modified batch process" differs only in that the concentrate step is eliminated. Both the "batch process" and "modified batch process" greases were prepared using the drill press stirrer. The data in Table 2 indicate a marked superiority of the Baragel 24 over

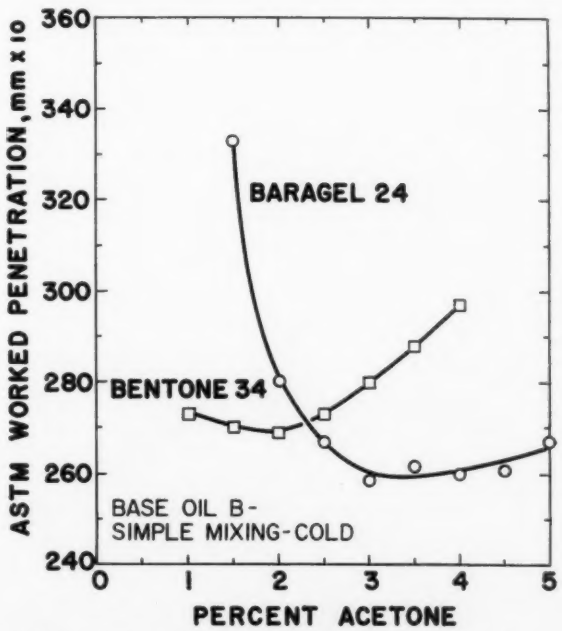

FIGURE 1, effect of dispersant on yield

Bentone 34 in oils characterized by an appreciable aromatic content.

Effect of Acetone Concentration

When these greases are prepared without heat, the observed penetration is a function of the dispersant concentration. The influence of the acetone concentration on Baragel 24 and Bentone 34 in oil base B is shown in Figure 1. Approximately twice as much dispersant was required for the Baragel 24 optimum as for Bentone 34.

Effect of Dispersant Type

Previous studies[9,10] have indicated that polar organic molecules have a marked effect on the behavior of the organophilic clays. The most outstanding are the highly polar, low molecular weight compounds; methanol, acetone, propylene carbonate, etc. Since the penetration of the grease is proportional to the amount of thickener present, yield curves were obtained using the simple mixing procedure and the optimum concentration of the additives named above. This procedure is essentially the same as the previously described kettle process with the exception of the heating step. These data are shown in Figures 2a and 2b. In base oil B, better yields were obtained with acetone and propylene carbonate than with methanol by the simple mixing process. Using the drill press method with heat, acetone and methanol are apparently equivalent and only slightly superior to propylene carbonate.

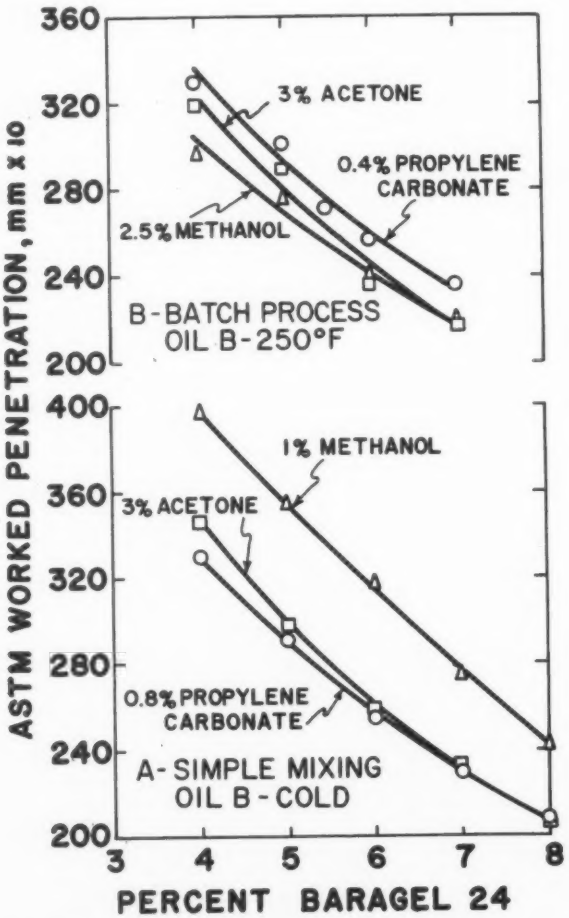

FIGURE 2, effect of dispersant type

Effect of Process on Dispersant Concentration

Unpublished data obtained by the Baroid Division Research Laboratories have indicated that less dispersant is required when high shear equipment is used to form the premix prior to colloid milling. Using heat in the premix stage is also beneficial. A drill press equipped with pitched sweep blades was used for comparison with the kettle previously mentioned. Rotary speeds of 250-500 rpm were used to achieve the higher shear rates. The mix was heated by means of a Glas-Col mantle using an autotransformer to control heating rate. A comparison between the two methods using propylene carbonate as the dispersant is shown in Figure 3. Approximately one-third as much dispersant is required by the drill press method as by the kettle process. Although less dispersant is required, the yields are comparable. The data for the solid circle were obtained by the kettle method, Figure 2, and agree within experimental limits with the value predicted by extrapolation of the drill press data.

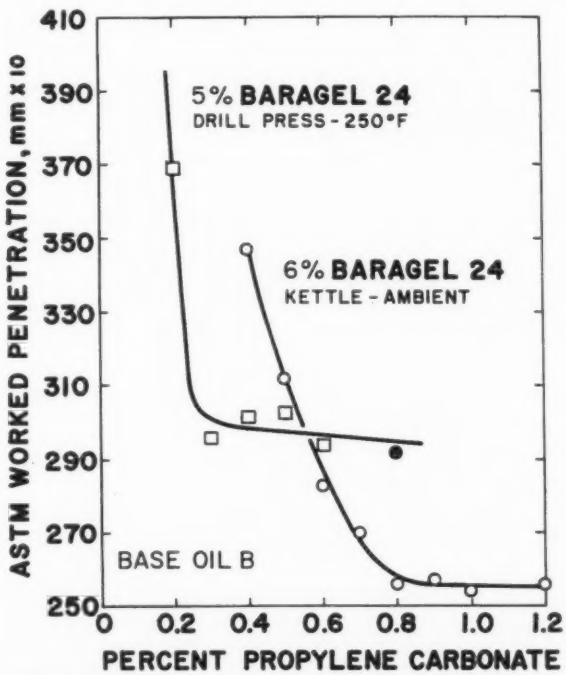

FIGURE 3, effect of process on dispersant concentration

Effect of Oil on Dispersant Concentration

Another factor influencing the amount of dispersant required is the composition of the oil used. A compari-

son of base oil A and base oil B is given in Figure 4. Base oil A is a solvent refined light intermediate neutral oil whereas base oil B is a conventionally refined coastal

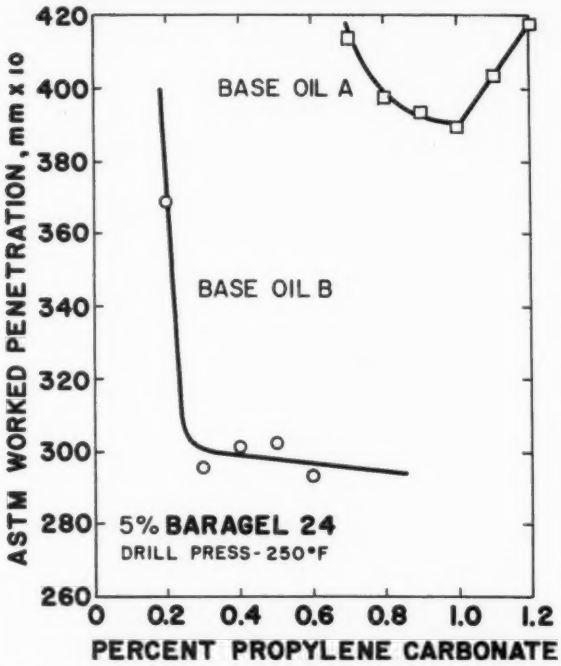

FIGURE 4, effect of oil on dispersant concentration

oil. The amount of dispersant required for the naphthenic oil is approximately one-fourth that required for the paraffin base oil. Also of interest is the shape of the curves. Using base oil B, a minimum penetration is rapidly approached which is essentially unaffected by further additions of dispersant. With base oil A, the amount of dispersant required for optimum yield is critical. It is also of interest to note the difference in yield in these two oils. This is felt to be related to the aromatic or aromatic and naphthenic nature of the oil.

TABLE 3
Effect of Dispersant and Process on Mechanical Stability

Process	*Per cent Baragel 24*	*Per cent Dispersant**	P_{60}	$P_{10,000}$	ΔP
Drill	5	0.2	369	395	26
Press		0.3	296	312	16
		0.4	302	315	13
		0.5	303	310	7
		0.6	294	312	18
Kettle	6	0.6	283	288	5
		0.7	270	281	11
		0.8	256	279	23
		0.9	257	267	10
		1.0	254	265	11
		1.2	256	278	22

* Propylene Carbonate

Effect of Dispersant and Process on Mechanical Stability

The penetrations of the greases used for Figure 3 were measured after 60 and after 10,000 strokes working in an ASTM motorized grease worker assembly. Experience has indicated that the 10,000 stroke value is greater (when the greases are measured immediately after working) than when measured in accordance with ASTM D217-52T. The results are shown in Table 3. Comparable greases were obtained by both processes.

Effect of Oil on Yield

Experience with the other organophilic clays has shown that the dispersant-yield curve for acetone and methanol using the drill press process follows those shown in Figure 3. Using data obtained by a simple mixing process, acetone concentrations were chosen so that the greases produced would represent optimum yield from the Baragel 24. These data are shown in Figure 5. For a 300 ASTM penetration grease, 7 per cent Baragel 24 was required with base oil A as contrasted to 4.5 per cent with base oil B.

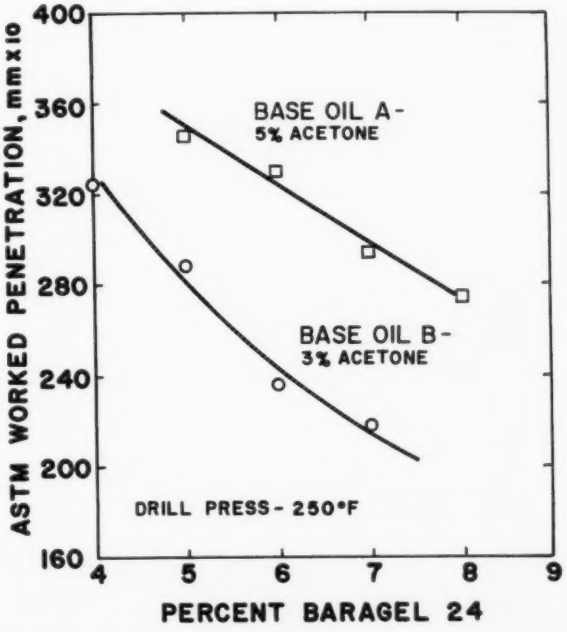

FIGURE 5, effect of oil on yield

Effect of Antioxidants on Baragel 24 Greases

Many of the antioxidants being used in lubricating greases have been found to be ineffective in organophilic clay based greases when a conventionally-refined coastal oil is used. Baragel 24 greases (7 per cent) were prepared using 0.4 per cent propylene carbonate in

base oil B by the heated kettle process. The antioxidants were incorporated prior to milling. After the usual period of time, the greases were evaluated by the ASTM worker test and the Norma-Hoffman oxidation test. These data are given in Table 4.

TABLE 4

Effect of Antioxidants on Baragel 24 Greases

Anti-Oxidant	*Per cent*	*ASTM Penetration, mm x 10 Unworked*	*60 Stroke*	*10,000*	*PSI Drop Per 100 Hours*
Ortholeum 300	0	232	247	257	23
	0.2	236	253	262	17
	0.6	230	242	256	12
	1.0	230	235	246	9
Vanlube 26	0	232	247	257	23
	0.2	225	235	235	22
	0.6	221	227	235	20
	1.0	216	227	240	13
Butyl Zimate	0	232	247	257	23
	0.2	229	240	270	4
	0.6	230	255	265	1
	1.0	226	239	264	2

Of the three antioxidants evaluated, Butyl Zimate proved more efficient in protecting against oxidation. It produced, however, the least mechanically stable grease. Both Ortholeum 300 and Vanlube 26 appeared to be beneficial with regard to both yield and mechanical stability and offered some degree of oxidation resistance. The above list does not mean to imply an endorsement of these three antioxidants. There are a great number of suitable materials available which are to be evaluated as soon as time permits.

Effect of Corrosion Inhibitors

In order to insure adequate protection against unusually severe operating conditions, corrosion inhibitors are often incorporated into lubricating greases. Greases were prepared from Baragel 24 and both a solvent-refined (A) and a conventionally refined oil (B). The influence of the inhibitors on yield, mechanical stability and protection against salt water corrosion was measured. For measuring corrosion inhibition, mild steel panels (2" x 4") were carefully cleaned, degreased and then coated with the grease being tested. Using a soft tissue, this coating was removed until only a very thin film could be detected. A 1/16 inch thickness of an emulsion containing 10 percent saturated (at 75°F) salt water in the test grease was then applied. The panel was then inserted into a humidity cabinet maintained at 120°F and 100 percent relative humidity for 68 hours. This test was originally devised for Bentone 34 greases. With these greases, a 24 hour test was found to be approximately equivalent to a 100 hour salt-fog test. However, a 68 hour test was required with the Baragel 24 greases in order to obtain a reference with an uninhibited grease equivalent to the above. This reference was given an arbitrary rating of 10, a clean panel was rated zero. The data for three commercial inhibitors are given in Table 5. These greases contained 6 percent Baragel 24 and were prepared by the modified batch process using 5 percent acetone as the dispersant. The inhibitor was added after the water addition just prior to milling.

TABLE 5

Effect of Corrosion Inhibitors on Baragel 24 Greases

Inhibitor	Percent Inhibitor	ASTM Penetration, mm x 10 Unworked	60 Stroke	1000	10,000	Corrosion Rating
Oil A						
Sarkosyl LC	0.0	317	330	363	Fluid	10
	0.05	315	330	361	390	5
	0.1	320	333	361	384	1
	0.2	329	339	358	394	¾
	0.5	312	327	361	386	¼
	1.0	320	351	370	399	0
Sarkosyl S	0.0	317	330	363	Fluid	10
	0.05	336	346	368	Fluid	8
	0.1	331	345	367	Fluid	5
	0.2	326	342	363	395	¾
	0.5	298	324	354	379	0
	1.0	307	315	—	361	0
Vanlube 71	0.0	317	330	363	Fluid	10
	0.05	320	348	365	Fluid	8½
	0.1	318	333	363	382	9
	0.2	323	338	365	Fluid	8½
	0.5	321	341	365	Fluid	8½
	1.0	328	341	363	399	8½
Oil B						
Sarkosyl LC	0.0	247	274	309	314	10
	0.05	240	266	268	297	5½
	0.1	237	266	268	282	4½
	0.2	240	255	263	290	2
	0.5	245	258	264	295	0
	1.0	259	277	273	303	0
Sarkosyl S	0.0	247	274	309	314	10
	0.05	256	286	288	310	6¼
	0.1	259	296	304	323	3½
	0.2	256	306	317	330	2¾
	0.5	263	320	335	344	0
	1.0	273	324	337	343	0
Vanlube 71	0.0	247	274	309	314	10
	0.05	259	279	283	298	10
	0.1	265	314	330	337	10
	0.2	259	303	318	336	9
	0.5	250	289	303	335	9
	1.0	266	293	306	334	9

The panels were run in duplicate and each panel rated individually. Where a panel rating fell in between two references, it was rated as ½ greater than the lower reference panel. This accounts for the quarter fractions for the averages and should be taken to indicate only that the average is greater than the reference number included in the rating. In both oils, approximately 0.5 percent of either of the Sarkosyl compounds gave complete inhibition. No deleterious effects were observed on the yield or mechanical stability in oil A. With Sarkosyl S in the conventionally refined oil (B), a loss in yield proportional to the amount of inhibitor was observed. The Sarkosyl compounds are described as N-acyl sarcosine compounds.

Effect of Extreme-Pressure Additives

The Vanlube 71 evaluated for corrosion inhibition was reported to be a very effective extreme-pressure additive. This material is described as being a 50 percent solution of lead diamyl dithiocarbamate in oil. Greases were prepared in oil B with 6.5 percent Baragel 24 and 4 percent acetone by the modified batch process. The additive was incorporated after the water addition and prior to milling. These data are given in Table 6.

TABLE 6

Effect of Extreme-Pressure Additives on Baragel 24 Greases

Percent	*ASTM Penetration, mm x 10*				*Timken Test Load, Lb*	
Vanlube 71	*Unworked*	*60 Stroke*	1000	10,000	*Pass*	*Fail*
0	265	258	274	305	10	13
2	252	268	265	277	40	45
3	253	253	260	302	40	45
4	255	232	238	288	40	45

The Vanlube 71 had only a slight, perhaps beneficial, effect on yield and mechanical stability. Although 2 per cent increased the Timken passing load from 10 to 40 pounds, further additions did not increase the load carrying capacity of the grease. However, a copper strip corrosion test indicated this additive to be very corrosive to copper. According to the manufacturer, this is true only if moisture is present. Other extreme-pressure additives will be evaluated as soon as time permits.

Behavior in Non-Mineral Oils

In many applications, mineral oils are physically unsuited as a lubricating grease base. The yield and mechanical stability of three non-mineral oil-Baragel 24 greases are given in Table 7. Ucon LB 625 is an oil of the polyalkylene glycol type. Using the Armstrong kettle, the oil, Baragel 24 and 1 percent propylene carbonate were heated to 215°F. After cooling, 0.1 percent water was added. The grease was milled by means of a Tri Homo disperser set at 0.001 inch rotor-to-stator clearance and fed at a rate of approximately 0.5 lb. per min. This same procedure was also employed in preparing the castor oil grease. For the Plexol 201 (di 2-ethylhexyl sebacate) grease, 2 percent of a 3:1 acetone to water mixture was used and the mixture heated to 225°F. The sample containing 12.5 percent Baragel 24 was prepared by adding the Baragel 24 and the dispersant (2½ percent) to one-third of the oil to form a concentrate. No heat was used in the preparation of this sample. Phenyl beta-naphthylamine (0.1 percent) was added prior to milling.

TABLE 7

Behavior of Baragel 24 in Non-Mineral Oils

Oil	*Percent*	*ASTM Penetration, mm x 10*			
Used	*Baragel 24*	*Unworked*	*60 Stroke*	1000	10,000
Ucon LB 625	8	297	317	337	357
Castor Oil	10	306	326	344	363
Plexol 201	10	339	346	358	365
	12.5	197	206	—	232

Summary

Baragel 24 greases can be prepared satisfactorily with aromatic-type mineral oils, vegetable and synthetic oils. The product is related to the process, composition of the oil, type of dispersant and amount used. Antioxidants, corrosion inhibitors and extreme-pressure agents can be successfully incorporated.

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About the Author

R. E. Fariss *received a BS degree in chemical engineering from Rice Institute in* 1942. *He was associated with Dow Chemical Co. as a research chemical engineer, before joining the Naval Reserve in* 1944. *After release from the Navy two years later, he returned to Rice Institute, receiving a PhD degree in physical chemistry in* 1950. *Following a short period in the Bellaire research laboratories of the Texas Co., Mr. Fariss joined the Baroid division of the National Lead Co. in April,* 1951. *His activities there have been concerned with the development of the modified clay gelling agents. In May,* 1959, *these responsibilities were expanded to include the technical service laboratories. He has contributed previously to the NLGI* Spokesman.

Presented at the NLGI 27th annual meeting in New Orleans, October, 1959

REVIEW OF THE LUBRICATING GREASE INDUSTRY IN EUROPE AND LATIN AMERICA

By: D. C. Sandy
Standard Oil Company (New Jersey)

AN IMPRESSION IS current that the United States' export market for lubricating grease is diminishing. Therefore, an attempt has been made to analyze the local lubricating grease supply situation in Europe and Latin America. As the information to be presented will show, the larger countries in both Europe and Latin America already are supplying most of their requirements of lubricating grease.

As far as can be determined, such a survey of the lubricating grease industry has not been made in the past or at least it has not been published. As was the case in the United States prior to the first N.L.G.I. surveys made in 1957, the information available from governmental sources is not always on a consistent basis. Even when industry associations collected and published data, these used different bases in various countries. Therefore, it was necessary to make certain adjustments to the available data, using the author's best judgment, tempered by guidance from experts who were familiar with the situation in the various countries. It should be clearly stated that the figures to be presented probably do not represent absolute levels of activity. However, it is felt that valid conclusions can be drawn from the available data. For the purpose of this paper, lubricating grease is defined as a solid or semi-solid lubricant thickened with soap or inorganic thickener.

Lubricating grease manufacturing is an art which has been practiced for many years in many countries. In the early days, one could enter the lubricating grease business by possessing a strong back, a glib tongue, a rudimentary knowledge of the simplest kind of chemistry and only the small amount of capital or credit needed to rent a shed and buy some limited amount of supplies. Exactly where lubricating greases were first made is not known. The records of my company indicate that their Pittsburgh Plant was established in 1885 by two partners who engaged the services of an "experienced" Swedish greasemaker. Two English books published in 1898, one by Redwood and another by "an expert oil refiner" give formulas and manufacturing directions for "set or axle," "boiled or Stauffers," and "loco (soda)" greases. From the tone of these two books, it would seem that by the beginning of this century there were many companies engaged in this business in all parts of the world. As far as can be ascertained, the industry continued to consist of a large number of companies until World War II.

Consideration of events since World War II can best be examined by looking first at Europe. At the end of the war, many of the pre-war plants had been destroyed. Others had been damaged and subsequently repaired so they could operate on a makeshift basis. Even though most of the countries were short foreign exchange, particularly dollars, it was necessary to turn to the United States for the lubricants needed to help rebuild European industry. During the period between 1945 and now, most governments have exerted pressure on the lubricating grease industry, as well as other industries, to expand local production to meet local demands. The results of these governmental pressures, as well as the natural drive of any manufacturing operation to expand, are shown in Tables I and II which tabulate by country the local production and the quantity of imports and exports.

In Table I are given the countries whose imports are small compared with their exports or which have significant exports. French imports, it will be noted, are quite small; its exports largely are to French overseas territories. Germany both imports and exports but

is a small net importer. Italy appears to be self-contained. The Netherlands and the United Kingdom are small importers but large exporters. It should be mentioned that each of these countries ships about half of its exports outside the European area.

TABLE I

European Industry Situation Today

	Thousands of Pounds		
	Production	*Imports*	*Exports*
France	66,900	9,800	2,000
Germany	88,700	20,500	12,400
Italy	30,000	——	500
Netherlands	53,300	1,800	48,900
United Kingdom	89,600	5,100	44,800

Table II tells the same story for the other European countries. Norway and Sweden import much more than they produce and have insignificant exports. Belgium has relatively substantial imports but does some exporting. Denmark exports more than it imports but these shipments are believed to go mainly to the other Scandinavian countries. Finland seems to import about one-third her requirements. Switzerland, while a substantial producer, still has significant imports relative to its total demand.

TABLE II

European Industry Situation Today

	Thousands of Pounds		
	Production	*Imports*	*Exports*
Belgium	11,600	4,600	1,800
Denmark	6,000	1,000	3,000
Finland	2,500	1,100	——
Norway	800	3,600	——
Sweden	3,300	8,800	200
Switzerland	6,600	1,700	100

Table III summarizes the European situation. Exports are about twice imports, but when the disappearance of half the Netherlands and United Kingdom exports outside the European area is taken into account, Europe as a whole appears to produce about the amount of lubricating grease it consumes.

TABLE III

European Industry Situation Today

	Thousands of Pounds		
	Production	*Imports*	*Exports*
Europe (Total)	359,300	58,000	113,700
Exports Outside Europe			46,800
Exports to European Countries			66,900

It previously has been pointed out that almost from the beginning of the lubricating grease industry, there have been a number of companies engaged in the manufacture of lubricating greases. In Europe, this still seems to be the case. The number of plants now known to exist is shown in Tables IV and V. Table IV lists the number of plants in the major producing countries. It will be noted that Italy and Germany have 30 and 53 respectively, lubricating grease manufacturing plants. All of those in Italy are believed capable of producing a complete line of greases while 40 of the German plants are similarly equipped. France and the United Kingdom have a smaller number of plants, 12 and 13 respectively. Four of the plants in France and five in the United Kingdom produce a complete line of products. In the Netherlands, there are only three plants, all of which are understood to manufacture a full line of products. Available information on the grease plants in these major producing countries indicates that at least one plant in France, one in Germany, two in the Netherlands and two in the United Kingdom are modern plants which have been built since World War II.

TABLE IV

Grease Plants

	Complete	*Limited*
France	4	8
Germany	40	13
Italy	30	
Netherlands	3	
United Kingdom	5	8

TABLE V

Grease Plants

	Complete	*Limited*
Belgium	9	10
Denmark	1	3
Finland	1	
Norway		1
Sweden	3	
Switzerland	4	3

Table V gives similar information on the plants located in the countries which have a smaller volume of lubricating grease production. In Belgium, there are 19 plants, nine of which produce a full line of products. Denmark has four plants but only one of these is a modern plant capable of making modern day quality. Very little is known about the facilities which are available in Finland. The one plant located in Norway is capable only of making the simplest type of conventional lubricating greases. It is understood that all three of the plants in Sweden have modern equipment. Four of the seven plants located in Switzerland are reported to produce the full range of modern lubricating greases.

In summary, Table VI indicates that in total there are 146 lubricating grease manufacturing plants in

TABLE VI

Grease Plants

	Complete	*Limited*
Europe (Total)	100	46

Europe, 100 of which can make a complete line of products and at least some of which are of recent modern construction. So far as is known, no announcements have been made of the planned erection of new lubricating grease plants in Europe.

The available information which has been presented on the quantity of grease produced, imported into and exported from Europe, and that on the type of equipment available, definitely points to the conclusion that Europe is in a position to supply its lubricating grease requirements, both as to quality and quantity.

Turning now to South America, the same type of information as presented for Europe on production, imports and exports, is given in Table VII. Here, again, it can be seen that the more industrialized countries such as Brazil and Argentina, produce large quantities of

TABLE VII

South American Industry Situation Today

	Thousands of Pounds		
	Production	*Imports*	*Exports*
Brazil	23,300	300	
Argentina	27,800		
Uruguay	1,400		
Chile	4,900	2,900	
Colombia	6,700		
Peru	3,500		
Cuba	1,700	1,900	
	69,300	5,100	

lubricating greases and apparently are substantially self-sufficient since they import negligible quantities. The production in Uruguay, Colombia and Peru, while comparatively small, appears substantially to satisfy the requirements of these markets. Chile and Peru do have some lubricating grease manufacturing facilities. However, the output of these plants must be supplemented by imports in order to meet the requirements of the marketers. It might be pointed out that the lack of foreign exchange has been even more critical in South America than it has in Europe and that, therefore, it has been more necessary to use products which could be made in existing local facilities even at some sacrifice in the qualities of lubricating greases which might have been desired than was the case in Europe.

Table VIII

Grease Plants

	Complete	*Limited*
Brazil	3	5
Argentina		4
Uruguay		2
Chile		4
Colombia		1
Peru	1	
Cuba		1
	4	17

This latter point is emphasized when Table VIII is reviewed. It will be noted that there are 21 lubricating grease plants known to exist in South America. Of these, however, only the three new plants in Brazil and one plant in Peru are capable of producing a complete line of products.

It is understood that a new grease plant is under construction in Venezuela and that the output of this plant probably will be large enough to supply the demands of that market.

In summary, it can be said that both Europe and Latin America appear to have sufficient productive capacity for lubricating greases to supply the requirements of their local markets. The facilities which are available in Europe are such as to produce modern quality products over the complete line of solid lubricating greases. Although the construction of new facilities in this area has not been announced, there seems no reason to believe that these countries will not continue to be self-sufficient. Parenthetically, you will have noted recent reports which indicate that in Europe, dollar availability is no longer as great a problem as it has been in the past. However, one reason for this is the steps which the international oil companies have taken to reduce the dollar drain on the treasuries of the various European countries. Any increased imports of petroleum products from the United States into Europe would, from the standpoint of the European governments, be a step in the wrong direction. In South America, local production is largely meeting local requirements. However, in this area there would seem to be room for the installation of more modern equipment if local suppliers are to meet the demands for modern-day, higher-quality products. ■

About the Author

D. C. SANDY *graduated from Dartmouth college with an AB degree in* 1934. *He received an MS degree from the University of Pittsburgh in* 1939. *In August*, 1934, *he joined Penola, Inc., now a subsidiary of Esso Standard Oil Co. He entered the U. S. Navy as a lieutenant* (jg) *in* 1942, *serving with the fuels and lubricants section, Bureau of Ships, technical section U. S. Naval Attache's office, London, and the U. S. Naval technical mission for Europe. He returned to inactive duty in the Naval Reserve with the rank of commander in* 1946. *He joined Jersey Standard in February*, 1947.

Literature and Patent Abstracts

Composition

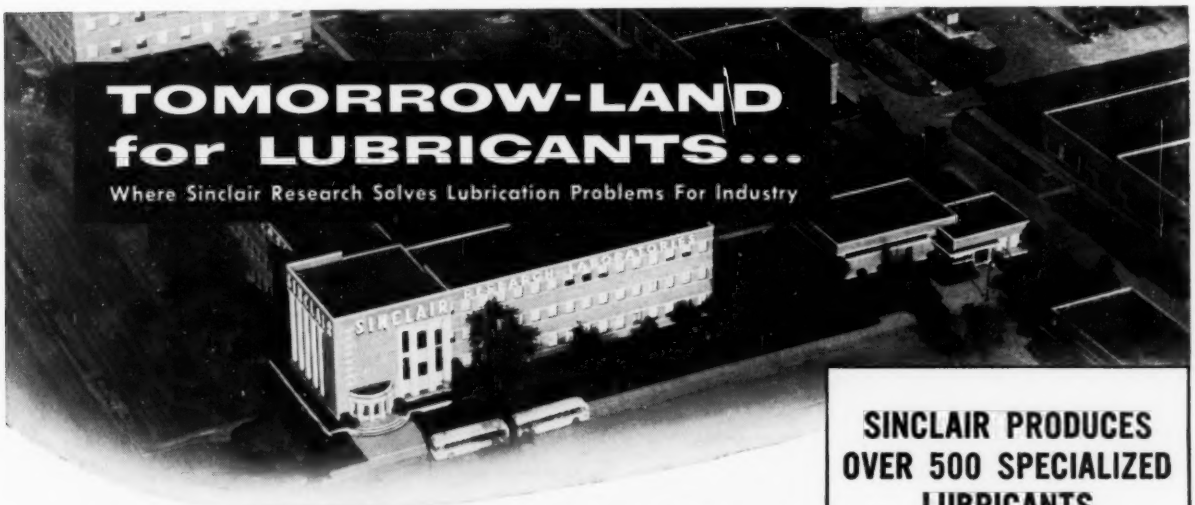
Oxidation Inhibitor for Anhydrous Calcium 12-Hydroxy Stearate Greases

Certain metal salts of the diesters of dithiophosphoric acids have been found of value as oxidation inhibitors when used in a proportion of 0.1 to 5.0 per cent by weight in anhydrous calcium 12-hydroxy stearate lubricating greases. Thus, by adding 1.0 per cent of either nickel, lead or lithium salts of di-(2-ethylhexyl)-dithiophosphate to the above calcium base lubricant drops in oxygen pressure during 500 hours in the Norma-Hoffman test were respectively 6 pounds, 6 pounds and 7 pounds. Zinc, barium and vanadium salts, on the other hand, when added to the same lubricating grease and subjected to the bomb test gave losses of 34 pounds in 500 hours, 55 pounds in 360 hours and 55 pounds in 36 hours.

Nelson and Kleinholz (U.S. Patent 2,899,388, assigned to Sinclair Refining Co.) found these salts of less value when added to lubricating greases made from soaps of other metals. For example, in a lithium base lubricating grease made from 12 hydroxy stearic acid 1.0 per cent of the nickel salt of di-(2-ethylhexyl)-dithiophosphate gave a mixture which lost 48 pounds pressure in 500 hours in a bomb test. A similar lead salt in the lithium lubricant lost 16 pounds pressure in 500 hours and a mixture with a lithium salt showed a loss of 55 pounds pressure in 105 hours.

Glass Fiber-Thickened Lubricating Greases

According to Postelnek (U.S. Patent 2,900,338, assigned to United States of America as represented by the Secretary of the Air Force) 2 to 15 per cent by weight of glass fibers, having diameters less than 3 microns, can be used to thicken lubricating fluids to grease consistency. The length of the fibers may vary from ⅛ to 2 inches. With such thread like particles there is



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As an illustration, to 48 grams of DC 550 fluid were added 2 grams of borosilicate glass fibers of 0.25 to 1 micron in diameter and lengths ranging from ¼ to 2 inches. A firm grease was obtained of medium penetration which withstood heating to 400°F. for over three days without appreciable degradation. The lubricant also possessed water- and alkali-resistance and good rust-inhibiting properties.

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Anhydrous Calcium Base Lubricating Greases Containing Free Fatty Acids

Anhydrous calcium base lubricating greases are described by Martinek and Fronczak (U.S. Patent 2,900,340, assigned to the Pure Oil company) which are stabilized by the presence of 0.3 to 1.85 parts of free fatty acids to each 20 parts of soap. This composition is particularly adapted to the use of mixtures of equal amounts of 12-hydroxy stearic acid and monounsaturated fatty acids used in both the soap formation and in adjustment of the free acid content. Also if the lubricating oil used contains any acidity, such as naphthenic acids, this should be neutralized with sodium hydroxide before the formation of calcium soaps.

Thus, 300 grams of bright stock, charged to a grease kettle, were agitated and heated to 170°F. before the addition of 1.5 grams of sodium hydroxide dissolved in 4.5 grams of water. Next, while the mixture was held at 190°F., 109.8 grams each of 12-hydroxy stearic acid and of oleic acid were added followed by a slurry of 30.6 grams of hydrated lime in 100 grams of a 200 SUS at 100°F. solvent neutral oil. The vessel in which the lime slurry was made was flushed out with 80 grams more oil which was added to the grease kettle. Upon addition of the lime slurry the temperature of the mixture went to 202°F. and after further heating to 212°F. where it was held for 15 minutes. Upon additional heat being applied the mass separated into two phases at 214°F. The acidity, as oleic acid, was found to be 1.79 per cent at this point, therefore an additional 5 grams of each acid were added to bring the ratio of calcium soap to free fatty acids to 20 to 1.85.

The additional free fatty acids immediately caused the mass to become homogeneous. With additional heat the mixture became clearer and tougher until at 240°F., 1.5 hours after the addition of the lime slurry, a translucent, light green and smooth lubricating

grease was obtained. This was then diluted with a mixture of the above oils to a final soap concentration of 4 per cent. The product had a tapered-hole disc penetration of 153 unworked and 152 after 2000 strokes in a grease worker. It was said to be particularly adapted for use on track-rollers.

Synthetic Lubricating Fluids

A series of eight short articles, published in Industrial and Engineering Chemistry Vol. 51, No. 5, pages 49A to 58A, May 1959, are of interest to our industry. The total production of synthetic lubricating oil in 1958 was about 10,000,000 gallons but by 1965 is expected to reach 70,000,000 gallons.

Only two of the articles specifically mention use in lubricating greases. Ragborg and Currie (p. 49A) cover the subject of silicones. A greaselike product consisting of silicone fluids with suitable thickeners (not named) and corrosion preventative is said to be ideal for threads of mortar shell fuses where it stays plastic from -65 to 160°F., stands long periods of storage and does not affect the materials with which it is in contact. Also a silicone thickened lubricating grease, mentioned in a previous abstract, is useful at high temperatures in ball bearings.

Moreton and Seil (p. 55A) tabulate six types of synthetic lubricating fluids and rate them as to various characteristics. A note after each type indicates the general uses. References to use in lubricating greases are as follows:

Dibasic acid esters—low volatility grease bases

Phosphate esters – low volatility grease bases

Silicones – low volatility grease base for lightly loaded bearings

Silicate esters – low volatility – low viscosity grease bases

Polyglycol ethers—low temperature grease bases

None of the articles furnish any indication of the proportion of the total gallonage of synthetic fluids which are used in the manufacture of lubricating greases.

Additives

Use of Additives to Keep Increasing

An article in *Oil Gas Journal*, June 1, 1959, page 96, while not mentioning the use of additives in lubricating greases does indicate the trend in the use of such products. It is felt that the rate of growth in the additive market will be even greater than that of the products in which they are used. The estimated amount of E.P. additives which will be used this year is 60 million pounds. In lubricating oils the poundage of additives continues to increase despite the relatively stable lube oil market. Thus the

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usage was 40 million pounds for such purpose in 1940. In 1945 the figure was 170 million pounds and in 1955, 560 million pounds, whereas in 1959 it is estimated that 680 million pounds of additives will be used in lubricating oils.

Application

Development of Special Lubricants and Lubrication Practices for Small Apparatus

F. Hardy, *Lubrication Engineering*, 15, No. 8, August, 1959, p. 328-332

A comparison of results when telephone dials were lubricated with either a light oil or a semi-fluid lubricating grease are very complimentary to the latter. In fact photographs taken after 500,000 operations with the oil show excessive wear of intermediate gear bearing. A similar picture after 1,000,000 operations using the semi-fluid lubricant shows no wear and a pool of the lubricant around the bearing.

The functional requirements of a satisfactory lubricant are listed as:

1. It must not materially change dial speed through a temperature range of 50 to 120°F.

2. Must be fluid enough to flow readily into bearings.

3. Should leave no gummy deposits.

4. Must protect against corrosion.

5. Should not creep onto the friction surfaces of the governor.

6. Must prevent wear of parts and provide maximum life.

7. Smooth operation and little noise is desirable.

While a 40 centistoke oil met the first three requirements, a semi-fluid lubricating grease consisting of an oil with a viscosity of 240 centistokes at 100°F. and four per cent of calcium soap was found much more satisfactory.

Composition

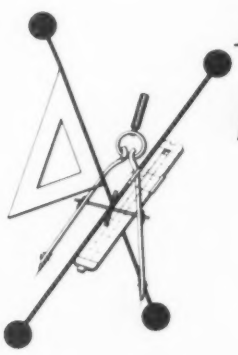
Gear Lubricants

Trowbridge and Woods (U.S. Patent 2,901,431, assigned to Shell Development company) describe gear lubricants which when used on semi-open or open gears have good adhesion over a wide temperature range, extreme pressure qualities and are water-resistant. Also the products in question are easy to handle and to apply.

While variations in the proportions of the ingredients are possible a preferred composition consists of a base mixture consisting of 40 per cent by weight of lubricating oil and 60 per cent by weight of asphalt derived from crudes which are predominantly aromatic. To the base is added about 7 per cent by weight of lead naphthenate, about 6 per cent by weight of polychlornaphtha xanthate containing about 30 per cent chlorine and about 10 per cent sulfur, and 1 per cent of butyl stearate.

Formation of the polychlornaphtha xanthate is illustrated by the following: Petroleum naphtha (Stoddard solvent) was chlorinated by bubbling chlorine gas therethrough until it contained about 52 per cent by weight chlorine. 225 parts by weight of this chlornaphtha was admixed with 400 parts of acetone and 100 parts of potassium amyl trithiocarbonate. This mixture was refluxed with stirring on a water bath and heated for one and one-half hours, after which it was cooled and filtered to remove the potassium chloride. The acetone was removed by distillation, after which benzol was added and distilled off to insure removal of water from the product. This gave a bright liquid containing 35 per cent chlorine and 10 per cent sulfur which was soluble in lubricating oil.

Since "Santopoid S" is a similar



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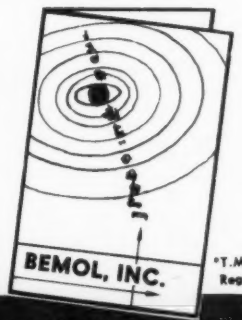

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polychlornaphtha xanthate, 6 per cent of this was used in the composition previously listed. When tested on a Timken Lubricant Tester, the resulting gear compound was said to indicate excellent load carrying capacity.

Gear Lubrication

A Look at the Problem of Gear Lubrication

A. Hundere, *Lubrication Engineering*, 15, No. 9, 358-59, 371 (1959)

The purpose of the article is to indicate the importance of finding out more about gear lubricants and pointing out that research should be directed toward learning the mechanism of gear lubrication. Once this is accomplished it is hoped that the service performance of lubricants can be accurately predicted by simple laboratory tests. A bibliography of sixteen articles relative to this subject is included.

A Laboratory Rating Method for Extreme Pressure Gear Lubricants

A. J. De Ardo and L. B. Sargent, Jr., *Lubrication Engineering* 15, No. 9, 367-371 (1959)

The authors' experience indicates that for classification of heavy duty gear oils, the combined results of tests Falex, Timken and Four-Ball machines are more significant than that given by any one machine. The load bearing capacity of each machine is tabulated against an arbitrary rating and the sum of the ratings permits of an evaluation of the lubricant. Recognition is made of the fact that the machines in question give some deviation in tests. For example in ten tests on a Timken machine of a MIL-L-2105 SAE 90 Gear Oil Ok loads varied from 50 to 60 pounds and psi values from 11,100 to 15,700.

Book Review

Industrial Fatty Acids, edited by E. Scott Pattison and published by Reinhold Publishing Corp., 1959

This book consists of sixteen short chapters written by men conversant with specific industries. One

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such chapter, thirteen pages in length, is written by E. F. Wagner and is entitled "Applications of Fatty Acids in Metallic Soaps and Greases." Since less than half of this space is devoted to the latter subject, the coverage of lubricating greases is very general.

This writer states that the greater proportion of lubricating greases are made from whole fats, that is glycerides, and that the greater proportion of fatty acids used are of tallow origin. Also it is mentioned that "there appears to be a definite trend toward the use of high stearic content fatty acids for use in soda base lubricating greases."

The test states that lithium base lubricating greases are effective lubricants "under high-temperature conditions (400°F.)." This statement may be open to question.

A tabulation of the consumption of fatty acids by different industries shows that no one field of use represents more than 15 per cent of the total of some 400 million pounds consumed annually. Lubricants account for slightly over 6 per cent of the total.

In general, the book indicates the tendency to continually upgrade and chemically modify fatty acids for use in all industries including that of the manufacture of lubricating greases.

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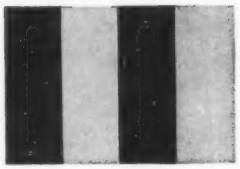

People in the Industry

Wallace & Tiernan Promotes Ainsworth

Charles H. Rybolt, vice president in charge of chemical divisions for Wallace & Tiernan Inc., announces that, effective January 1, Bruce Ainsworth became president of the Harchem division. In this capacity he will be responsible for all division activities including research, product development, production and sales.

Mr. Ainsworth, formerly assistant to Mr. Rybolt, came to Wallace & Tiernan from the Celanese Corporation of America.

T. C. Jones Becomes President of Nalco

Thomas C. Jones became president of Nalco Chemical Co., Chicago, January 1.

Joseph A. Holmes, former president, became vice-chairman of the board of directors, a position previously vacant.

Mr. Jones has been a member of the Nalco board of directors since 1953 and a member of the company's executive committee since 1954. An executive of the Aluminum Company of America, with which he has been associated for over 40 years, Mr. Jones is manager of its Chicago district.

Nalco Chemical Co. is a manufacturer of industrial chemicals, with sales of approximately $45,000,000 a year.

Vulcan Names Hofman

Robert W. Hofmann has been named to the newly-created post of technical service representative at Vulcan Containers Inc., 43-year-old steel pail and drum manufacturer here, it has been announced

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by Vern I. McCarthy, Jr., president.

In his new position, Mr. Hofmann's duties will include liaison between customers, field sales representatives and plant production, Mr. McCarthy said. In addition, Mr. McCarthy said, Mr. Hofmann's wide experience in graphic arts will be invaluable in advising metal container users anxious to take advantage of the new color and design possibilities now available to packagers of industrial products.

Mr. Hofmann will also be responsible for counseling in the use of Hi-bake protective interior linings for the ever expanding number of commodities and products shipped and stored today in steel containers. According to the announcement, the new post was created in response to the increasing complexity of container usage. Mr. McCarthy called the appointment a "significant forward step in manufacturer-customer relations in our field."

Prior to joining Vulcan, Mr. Hofmann was employed for twenty years with the Flint Ink corporation, Broadview, Illinois. For fifteen years he held the post of plant superintendent in charge of quality control, production and purchasing for Flint.

ASA Appoints Three

Three new officers have been appointed for sectional committee MH2, metal drums and pails, of the American Standards association.

Co-chairmen are O. X. Pitney, Rheem Manufacturing company, Linden, New Jersey, and R. S. Sawyer, United Steel Barrel Company, Philadelphia. Both men represent the sponsor of the ASA project on standardization of metal drums and pails, the Steel Shipping Container Institute.

Mrs. L. B. Miller of the Institute was appointed secretary of the committee.

The MH2 committee is responsible for the ten American Standard specifications for metal drums and pails currently in use, and is working on four new ones. In addition, it insures that the existing American Standards in the field are kept up to date.

The American Standards association is the coordinating body for voluntary national standardization. A non-profit organization, ASA provides the means for developing a single set of voluntary national standards called American Standards. It is a federation of 122 national trade associations, technical and professional societies and consumer groups. Some 2,000 companies are sustaining members.

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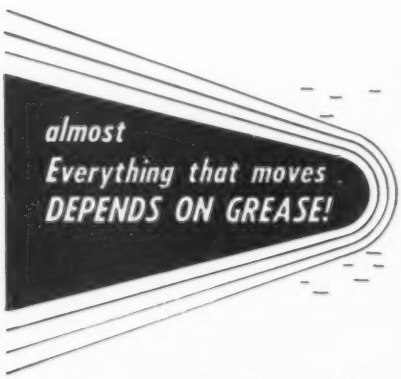
Industry News

Monsanto Names Mohrman to New Post

Harold W. Mohrman of Springfield, Mass., director of research-associated interests for Monsanto Chemical company's plastics division, has been promoted to the newly-created position of director of research for the company's overseas division, it was announced by Marshall E. Young, Monsanto vice president and general manager of the overseas division.

The appointment was effective Jan. 1, 1960. Mohrman will make his headquarters in St. Louis.

As research director, Mohrman will assist Monsanto's overseas subsidiary, associate and affiliate companies in sustaining maximum efficiency in their research activities. He also will coordinate their efforts with programs of the company's domestic laboratories.



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Gulf Builds Multi-Million Dollar Cyclohexane Plant

Gulf Oil corporation has completed a new multi-million dollar high purity Cyclohexane plant at its Port Arthur, Texas, refinery. Initial production is scheduled for February 1, 1960.

This new plant will add significantly to the nation's total supply of Cyclohexane and will produce a new high purity grade especially adapted to the manufacture of nylon.

Cyclohexane is also used as a solvent in the manufacture of polyethylene and as a raw material for the manufacture of plasticizers and synthetic lubricants.

Esso Standard and Carter Merge into Humble

Esso Standard Oil company and Carter Oil company have been merged according to plan into the new Humble Oil & Refining company, Morgan J. Davis, president of Humble, announced January 5.

The effective date of the merger was January 1. Both Esso Standard and Carter will operate as divisions of the Humble company.

The merger of Esso Standard and Carter into Humble is another major move in the large-scale merger program announced last September by Humble and Standard Oil company (N. J.)

The plan provides for the ultimate consolidation of five of Jersey Standard's domestic affiliates into one corporation, thereby bringing all of Jersey's producing, refining, marketing and marine operations in the United States under unified management.

The two other Jersey affiliates to be merged with Humble as soon as feasible are Oklahoma Oil company and Pate Oil company, both of which are marketing companies operating in the Midwest. Headquarters of the Esso Standard division will remain in the Esso building at 15 West 51st street, New York City. Headquarters of the new Humble company are in Houston. Esso Standard will continue to refine and market oil products in the eighteen Eastern and Southern states where it presently operates. NLGI's member firm designate is the Esso Standard division, with J. J. Coates of the Pittsburgh grease plant as Company Representative.

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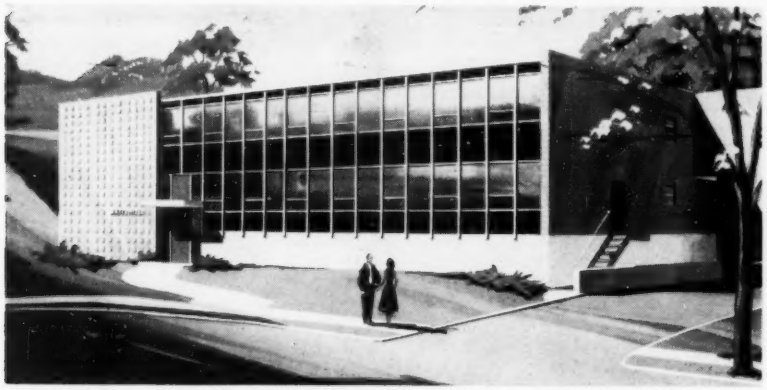

NEW office for Battenfeld (Kansas City), based on architects' design. On completion, parts of the present structure will become plant operation.

As part of the Battenfeld Grease and Oil corporation of Kansas City expansion program, a new two-story office building is now under construction at the south end of the plant, adjoining laboratory and dock facilities at the Missouri operation.

This new building, in addition to providing space for modern business machines, will also permit vacating area in the plant proper, which is now being used for executive and general offices. The area vacated will be used to expand and modernize plant operation consistent with increased demand for products, thus enabling the company to accomplish its goal of increasing plant facilities and improving over-all efficiency.

The new building will provide executive, sales and advertising offices and a lobby on the first floor. The general office staff, as well as the office manager, purchasing agent, comptroller, traffic manager, etc., will occupy the second floor. Also to be located on the second floor will be an entirely new machine room which will house a new IBM department. This new department will enable Battenfeld to convert its billing, invoicing and order writing to a machine operation.

Battenfeld is well known in the industry, having been incorporated in February, 1919. The founders were the late J. R. Battenfeld, and A. J. Daniel, now president of the organization.

Other officers of the company are: Hugh H. Bruner, executive vice-president; G. W. Krause, vice-president; Quentin L. McCabe, treasurer; and D. H. Vance, assistant treasurer.

Battenfeld is recognized internationally as a custom manufacturer of lubricating greases. In 1930, the company diversified its production by entering the field of waterproofing products. Today these products represent a goodly portion of the company output. The same policy of custom manufacturing prevails, and distribution of these products is on a national basis.

The late J. R. Battenfeld was one of three founders of NLGI, and A. J. Daniel has been Company Representative and a member of the Board of Directors since 1945. President of the Institute in 1950, Daniel was elected to his eighth consecutive term as treasurer at the recent annual meeting. C. J. Boner, chief chemist, is Technical Representative and chairman of the Tech-

(*Continued on page 452*)

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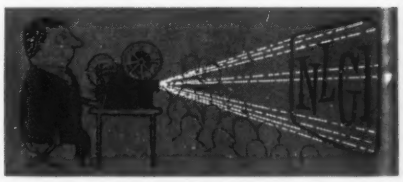

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SUPPLIERS OF MATERIALS FOR MANUFACTURING LUBRICATING GREASES

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30 Rockefeller Plaza, New York 20, N. Y.
Representative—B. H. Loper

American Potash & Chemical Corp.
99 Park Avenue, New York 16, N. Y.
Representative—W. F. O'Brien

film

"GREASE—THE MAGIC FILM" tells in 25 fast-moving minutes the wonderful story of lubricating grease, how this magic substance makes modern mechanical progress possible, and of the research and testing to insure a constantly better product. The 16mm movie, subsidized by NLGI, in sound and color, can also be obtained for foreign voice narration.

Kansas City 12, Missouri

Archer-Daniels-Midland Company
Chemical Products Division
P. O. Box 532, Minneapolis 40, Minn.
Representative—J. H. Kane

The Baker Castor Oil Company
120 Broadway, New York 5, New York
Representative—J. W. Hayes

Baroid Chemicals, Inc.
A subsidiary of National Lead Company
1809 South Coast Life Building
Houston 2, Texas
Representative—Mr. C. M. Finlayson

Godfrey L. Cabot, Inc.
125 High Street
Boston 10, Mass.
Representative—H. P. Donohue, Jr.

Climax Molybdenum Company
500 Fifth Ave., New York 36, New York
Representative—Elwin E. Smith

Darling & Company
4201 South Ashland Ave., Chicago 9, Illinois
Representative—G. W. Trainor

The Elco Lubricant Corporation
Jennings Road & Denison Avenue
Cleveland 9, Ohio
Representative—R. K. Smith

Emery Industries, Inc.
4300 Carew Tower, Cincinnati 2, Ohio
Representative—G. W. Boyd

Enjay Company, Inc.
15 West 51st St., New York 19, New York
Representative—Brian Casey

Foote Mineral Company
18 W. Chelten Ave., Philadelphia 44, Penn.
Representative—W. F. Luckenbach

A. Gross and Company
295 Madison Avenue, New York 17, N. Y.
Representative—Eugene W. Adams

The C. P. Hall Company of Illinois
5145 West 67th St., Chicago 38, Illinois
Representative—J. E. Stonis

Harchem Division Wallace & Tiernan, Inc.
25 Main St., Belleville, N. J.
Representative—W. G. McLeod

Humko—Chemical Department
P. O. Box 4607
Memphis 7, Tennessee
Representative—W. J. O'Connell

Lithium Corporation of America, Inc.
Rand Tower, Minneapolis 2, Minnesota
Representative—Malcolm M. Moore

The Lubrizol Corporation
Box 3057—Euclid Station, Cleveland 17, Ohio
Representative—J. L. Palmer

Mallinckrodt Chemical Works
2nd & Mallinckrodt Sts., St. Louis 7, Missouri
Representative—D. B. Batchelor

The McGean Chemical Co.
Midland Building, 101 Prospect Ave., N. W.
Cleveland 15, Ohio
Representative—W. A. Ritchie

Metasap Chemical Company
A Subsidiary of Nopco Chemical Co.
60 Park Place, Newark, New Jersey
Representative—T. J. Campbell

Monsanto Chemical Company
800 North Twelfth Blvd., St. Louis 1, Mo.
Representative—J. W. Newcombe

Newridge Chemical Company
7025 West 66th Place, Chicago 38, Illinois
Representative—T. E. Shine

M. W. Parsons—Plymouth, Inc.
59 Beekman St., New York City 38, New York
Representative—Herbert Bye

Werner G. Smith, Inc.
1730 Train Avenue, Cleveland 13, Ohio
Representative—W. Meckes, Jr.

Swift & Company
165th & Indianapolis Blvd., Hammond, Ind.
Representative—F. H. Beneker

Synthetic Products Company
1636 Wayside Rd., Cleveland 12, Ohio
Representative—Garry B. Curtiss

Witco Chemical Company
122 East 42nd St., New York 17, New York
Representative—E. F. Wagner

TECHNICAL AND RESEARCH ORGANIZATIONS

Battelle Memorial Institute
505 King Avenue, Columbus 1, Ohio
Representative—S. L. Cosgrove

The Chek-Chart Corporation
33 East Congress Parkway, Chicago 5, Ill.
Representative—H. Eldridge

Chemico (Pty.) Ltd.
Miller and 7th Streets, P. O. Box 6349,
New Doornfontein, Johannesburg,
South Africa
Representative—O. Richter

Compagnie Francaise De Raffinage
11 Rue du Dr. Lancereaux, Paris VIII[e], France
Representative—Albert E. Miller

Institut Francais du Petrole
CMrR—Courtel, 4 Place Bir Hackeim
Rueil—Malmaison (S. et Oise) France

Laboratoires de Recherches Purfina S.A.
98/100 Chaussee de Vilvorde,
Bruxelles (N.O.H.), Belgium
Representative—R. Gillerot

Phoenix Chemical Laboratory, Inc.
3953 W. Shakespeare Ave., Chicago 47, Ill
Representative—Mrs. G. A. Krawetz

nical subcommittee on procurement of papers for the NLGI SPOKESMAN. In 1955, Boner was given the Institute's "Award for Achievement" for the aid his book, *Manufacture and Application of Lubricating Greases*, has given to the industry, both in this country and abroad.

New Molybdenum Disulfide Lubricant Announced

A new molybdenum disulfide lubricant, Molykote M-55-Plus, for extreme pressure applications – on drills, taps, cold metal forming dies, punches, and such – has been announced by the Alpha-Molykote corporation, Stamford, Conn. It supersedes M-55, the well-known 5-per cent EP dispersion in medium oil, and out-performs its predecessor by 116 per cent in welding-load tests and 71 per cent in wear resistance tests.

Molykote M-55-Plus does not derive its extreme pressure characteristics from the fusion of additives like sulphur and chlorine at elevated temperatures, as do conventional EP lubricants. It is, thus, suitable for slow moving parts under heavy loads, and for surfaces which would be reactive with additives.

The improved lubricity of M-55-Plus, and its ability to "plate itself out" on metal surfaces, recommends it also for important wear reduction applications in sleeve bearings and instrument gears, even though lightly-loaded.

Application field reports and specification sheets are available on request.

API Publishes Third Evaporation Loss Bulletin

Publication of a new American Petroleum Institute bulletin entitled "Evaporation Loss from Tank Cars, Tank Trucks, and Marine Vessels" has been announced by J. H. McClintock of Esso Research & Engineering Co., chairman of the API evaporation loss committee.

The bulletin contains information on the magnitude of the evaporation losses during loading, in transit, and unloading tank cars, tank trucks, and marine vessels. Vapor-pressure charts and charts showing evaporation loss rates for various types of operations are included. The correlations reflect an analysis of industry data on this subject and provide a tool which can be used to detect, evaluate, and control evaporation losses in these phases of the industry's operations.

The bulletin is the third in the Institute's proposed series of preliminary publications on evaporation loss. The committee plans to produce a standard, giving available information on all aspects of evaporation loss, including its detection, reduction and control with attendant economic benefits.

Copies of the Bulletin No. 2514 may be obtained at $1 each from the New York office of the American Petroleum Institute, 1271 Avenue of the Americas, New York 20, New York.

Metasap Becomes A Nopco Division

R. F. McClellan, vice-president in charge of the industrial division of Nopco Chemical company, announces that its subsidiary of forty-two years, Metasap Chemical company, became a Nopco division effective January 1, 1960.

In this change, Tom Campbell, manager of the Metasap Chemical company and NLGI Company Representative, becomes manager of the newly-formed Metasap division. Likewise, the sales production and laboratory personnel will continue in their present capacities.

Metasap addresses have not been changed. All Metasap correspondence should be directed to the present addresses at Newark, New Jersey; Cedartown, Georgia; Richmond, California; London, Canada; Chicago, Illinois or Boston, Massachusetts.

HARSHAW LEAD BASE

Harshaw Lead Base, as an additive to petroleum lubricants, improves extreme pressure characteristics and imparts the following desirable properties:

- Increased film strength
- Increased lubricity
- Improved wetting of metal surfaces
- A strong bond between lubricant and metal surfaces
- Resistance to welding of metals at high temperatures
- Moisture resistance and inhibits corrosion

Harshaw Lead Bases are offered in three concentrations to suit your particular needs:

Liquid 30% Pb	Liquid 33% Pb	Solid 36% Pb

Other metallic soaps made to your specifications. Our Technical Staffs are available to help you adapt these products to your specific needs.

THE HARSHAW CHEMICAL CO.
1945 E. 97th Street • Cleveland 6, Ohio
Branches In Principal Cities

FISKE BROTHERS REFINING CO.

Established 1870

★

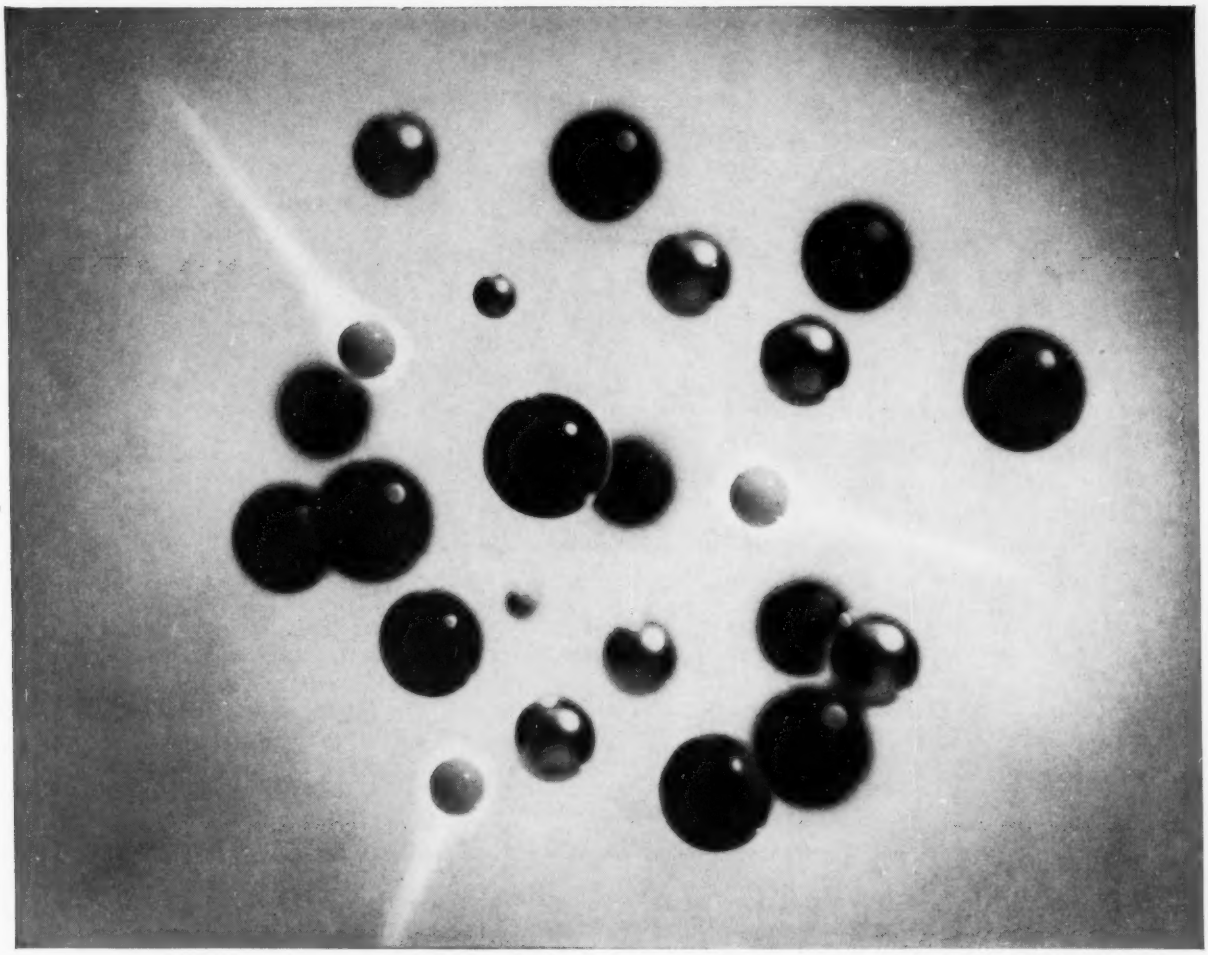
NEWARK, N. J.

TOLEDO, OHIO

★

Manufacturers of

LUBRICATING GREASES



Visual concept of the behavior of lithium ions in a fused salt bath

LILLIPUTIAN

Lithium ions get around . . . in the tightest places!

The lithium ion really puts small size . . . high charge density . . . and directional properties to work. Unlike the ions of other alkali metals, it's trim enough *and* active enough to replace many other metals in a variety of crystals.

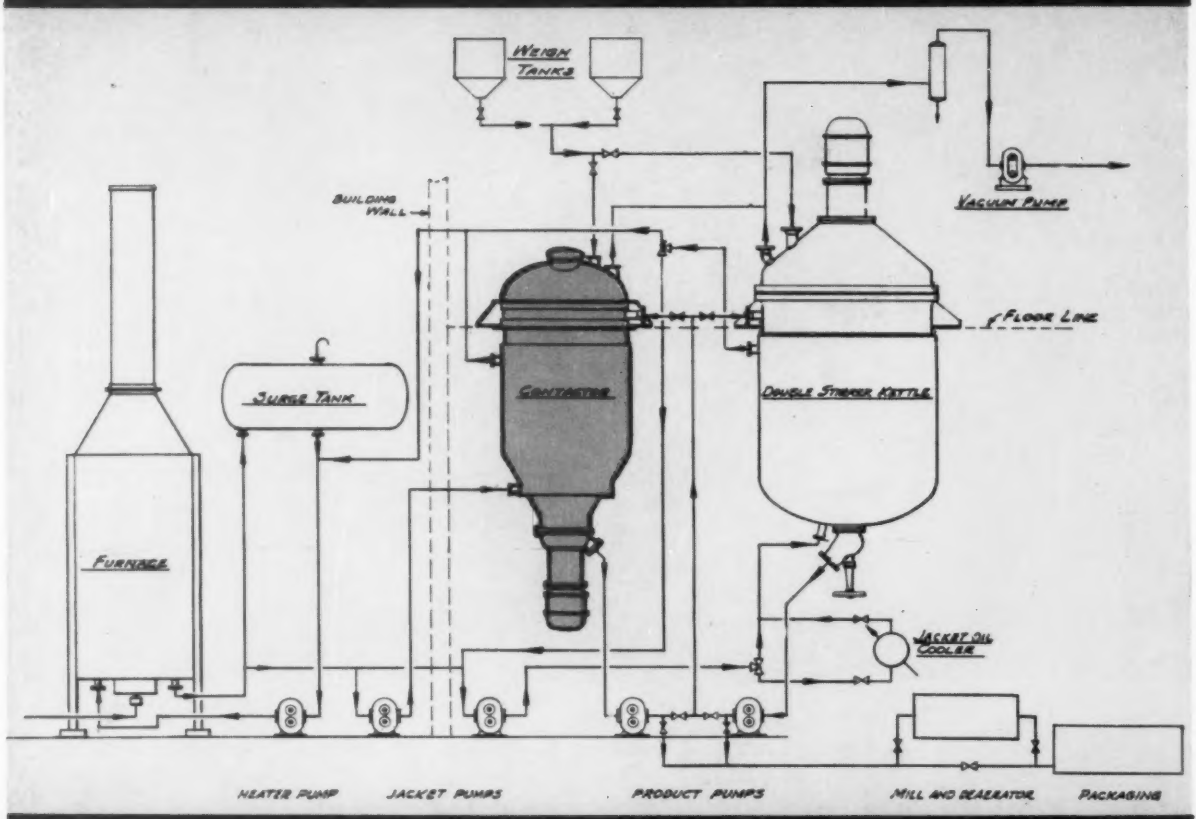
The small ionic radius of lithium, 0.60A, immediately suggests lithium's use in systems containing metals with ionic radii ranging from .5 to 1.0A. The resultant balance or unbalance created by such lithium substitutions may be used to produce significant stabilizing or catalytic effects. Ionic radius also makes lithium an excellent addition for increasing conductivity, and its high charge density can effectively decrease viscosity.

Small ionic radius, high charge density, and directional properties are just a few of the many unique characteristics that make lithium well worth investigation. Bring your knowledge of the subject up-to-date by requesting a copy of "Chemical and Physical Properties of Lithium Compounds"—a down to earth collection of facts, figures, and ideas on some 23 lithium compounds. Write the Technical Literature Dept., Foote Mineral Co., 402 Eighteen West Chelten Building, Philadelphia 44, Pa.

FOOTE MINERAL COMPANY

LITHIUM CHEMICALS, MINERALS, METAL • STRONTIUM CHEMICALS • ELECTROLYTIC MANGANESE METAL • WELDING GRADE FERRO ALLOYS • STEEL ADDITIVES • COMMERCIAL MINERALS AND ORES • ZIRCONIUM, TITANIUM, HAFNIUM (IODIDE PROCESS)

The STRATCO contactor



and How It Simplifies Grease Making

The Stratco contactor is a highly efficient mixing device and when combined with the heating and cooling system shown above provides extremely close control of reaction temperature. With intimate contact between reactants and controlled temperature, very short batch time cycles are required.

Compared with other systems, Stratco grease plants produce more uniform greases with less soap and require less laboratory control.

A complete Stratco plant layout is illustrated above. Equipment is adaptable to modernization programs as well as new installations. Specific equipment recommendations made without obligation.

STRATFORD ENGINEERING Corporation

612 West 47th St. *PETROLEUM REFINING ENGINEERS* Kansas City 12, Mo.